JOURNAL OF DAIRY SCIENCE

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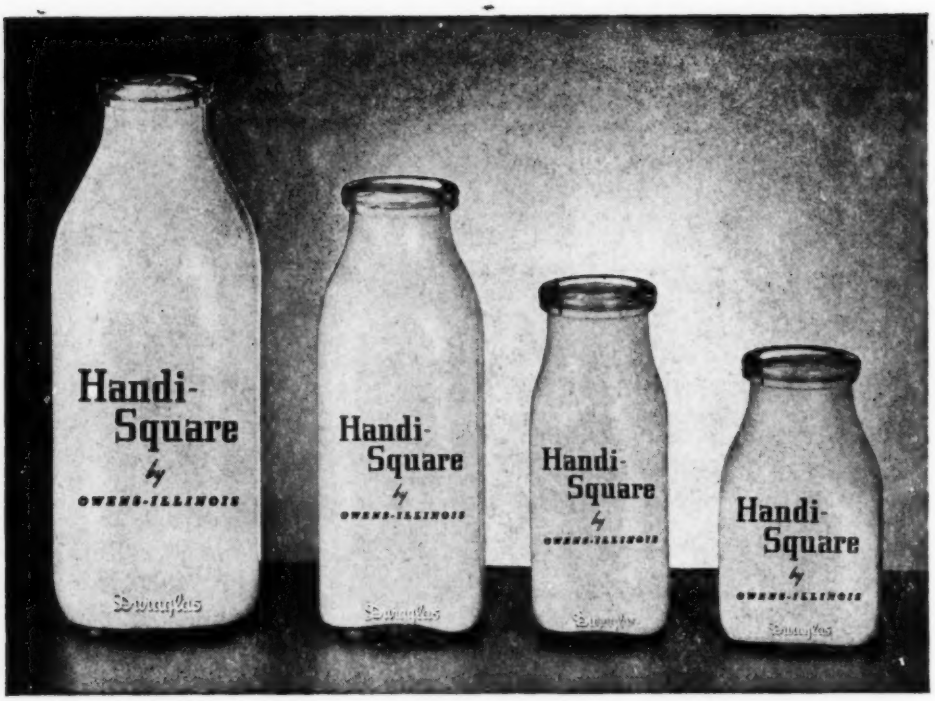

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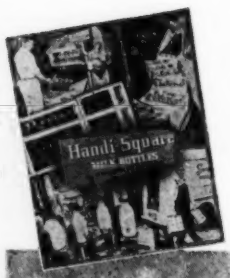

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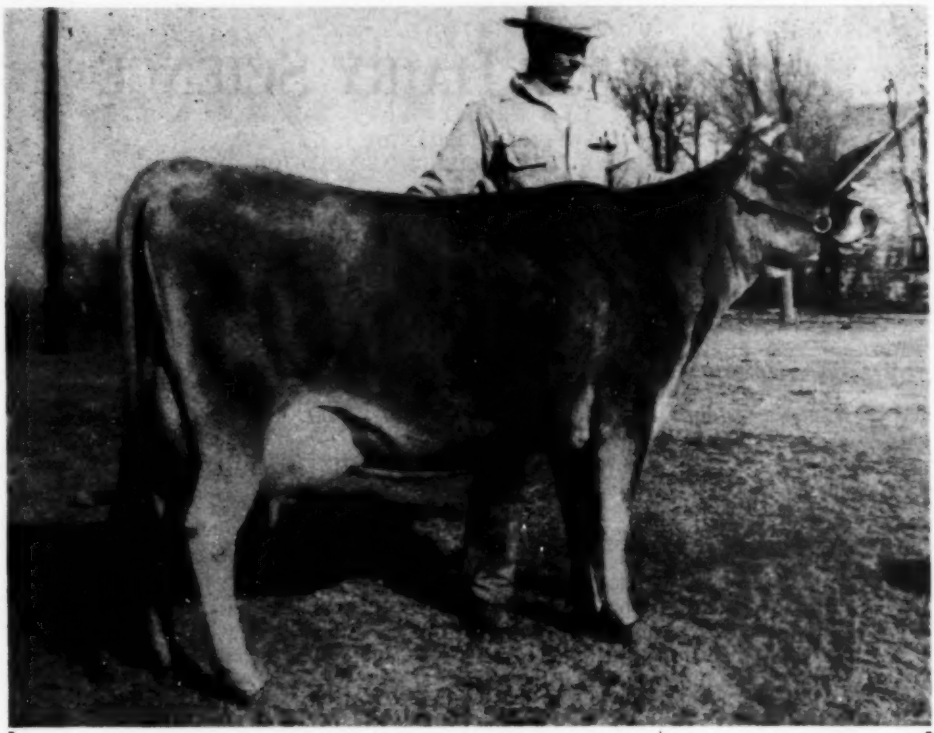

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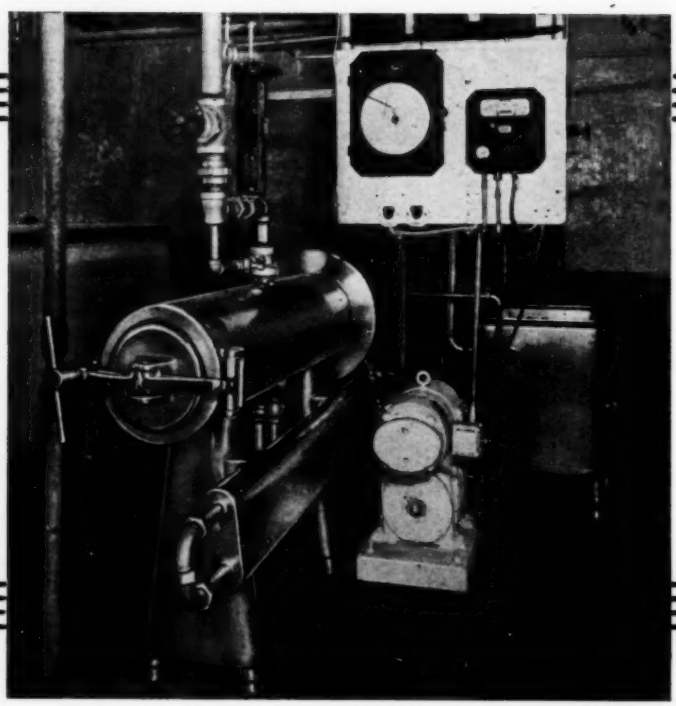

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A SPECTROPHOTOMETRIC STUDY OF THE CHANGES IN PEROXIDE VALUE OF SPRAY-DRIED WHOLE MILK POWDER DURING STORAGE

HARRY PYENSON AND P. H. TRACY

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Of the fatty acids present in milk (1), oleic and linoleic acids, being unsaturated, are probably most concerned in the oxidative changes that result in the production of oxidized flavor. It is thought by some that phospholipid material usually associated with the butterfat may also play an important rôle in oxidative changes.

Butterfat displays a certain initial resistance to oxidation. It then passes through a period during which there is little or no absorption of oxygen. This period is termed "the period of induction" and when it is over, the fat will absorb oxygen at an increasingly rapid rate. During the induction period combination with oxygen is slow and the resulting deterioration in flavor is usually slight. The phenomenon of the induction period is considered to be due to the action of traces of protective substances known as antioxidants or inhibitors, which delay oxidation and prevent the reaction between oxygen and the fat from attaining its full velocity. Natural fats contain traces of non-fatty compounds. These substances lengthen the induction period but in time lose their protective action and are themselves oxidized to a non-antioxygenic form.

A period of active oxygen absorption follows the period of induction. Linoleic acid has an extremely rapid rate of oxygen absorption but there is only 3–4 per cent of it present in butterfat. The oleic acid oxygen absorption rate is decidedly slower than the linoleic acid, but butterfat contains 25–40 per cent of oleic acid.

The process of fat deterioration resulting from oxidation is not well understood, but it is thought that several reactions occur simultaneously. The peroxides formed are an intermediate product of fat oxidation and are by no means the end product of the reaction. Further products of fat oxidation are thought to be aldehydes, ketones, keto hydroxy compounds and epihydrin aldehyde. Glycerol disappears practically as fast as it is formed, being oxidized immediately on formation.

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Peroxide values have been used with some success in determining the extent of oxidation of fats and oils in a pure or nearly pure state (5, 11). There are numerous methods that have been proposed for the detection and estimation of the degree of oxidation. Most of these methods, based on iodometric titrations, work out fairly well where pure or nearly pure fats and oils are used. In the examination of a material such as milk powder, in which the fat is intimately associated with other milk constituents, it is desirable to extract the fat by procedures least likely to decompose the fat-peroxides as they are intermediate products of oxidation.

Organoleptic methods are commonly used to detect off flavors in whole milk powder. In many pure fats and oils the keeping quality is determined by the length of induction period under controlled conditions. The longer the induction period the better the keeping quality of the fat or oil in question. Therefore, it was thought desirable to study the relationship beween peroxide value and the palatability or keeping quality of spray-dried whole milk powder.

REVIEW OF LITERATURE

Dahle and Nelson (4) studied antioxidants in dry milk fat. Their influence was measured by means of the peroxide number determined by the procedure of Greenbank and Holm (5). They found that the induction period may vary as much as four days between identical tubes of fat under the conditions employed.

Hollender and Tracy (10) used Smith's (14) method for the determination of peroxide values on roll-dried whole milk powder. They concluded from their study that: 1) the peroxide value cannot be used to detect early oxidation of the fat; 2) it may be used to show oxidation of a high degree; 3) the development of oxidized flavor in milk powder can be detected at an earlier stage by the sense of taste than by the use of the peroxide test; 4) the peroxide test could not be used to predict the keeping quality of a fresh sample of powdered whole milk.

Lea, Moran and Smith (11) using roll and spray whole milk powder showed that with the disappearance of free oxygen from the container both the peroxide and Kreis values passed through a maximum and fell away again to low values.

Greenbank, Wright, and Deysher (6) made a study of the effect of inert gas on the keeping quality of commercially manufactured and packed dried whole milk. They used flavor and peroxide values as indices of the keeping quality and conclude that in the air-packed samples there was good correlation between peroxide value and flavor, while in the nitrogen-packed samples the correlation was less evident.

Chapman and McFarlane (2) claim that there is a correlation between fat peroxide content and keeping quality in powdered whole milk when

using the colorimetric method which is based on the oxidation of ferrous to ferric iron.

Pyenson, Tracy and Trimble (13) analyzed 180 samples of spray-dried whole milk powder varying in age from fresh to 21 months for peroxide content and gas content. The reconstituted milk was also scored for flavor. They concluded that the peroxide value is not a satisfactory criterion of the palatability or keeping quality of spray-dried whole milk powder.

Holm (9) recently stated that, "the rate of oxidation of fats may be measured by that rate of formation of peroxides only if the oxidation takes place at relatively low temperatures and if the peroxide values are relatively small.

"At higher temperatures the rate of peroxide formation may not be a measure of the rate of oxygen absorption and the extent of peroxide formation may not necessarily be a measure of deterioration. This is especially true in the case of fats and oils which contain acids of high degree of unsaturation.

"The most satisfactory and practical method of measuring deterioration is by the time of appearance of off-odors and off-flavors, which are caused by the breakdown of peroxides."

EXPERIMENTAL PROCEDURE

Four commercial samples of spray-dried whole milk powder were obtained for this experiment. The batch numbers, dates of manufacture and age of powder when packed for gassing are as follows:

Batch No.	*Date of manufacture*	*Age of powder when gassed (days)*
A27	Jan. 27, 1944	15
A28	Jan. 28, 1944	14
A31	Jan. 31, 1944	11
B 2	Feb. 2, 1944	9

The powders were kept in air-sealed cans until they were gassed on February 11, 1944. Approximately 100 grams of powder was placed in each can. Part of the cans of each batch were nitrogen-packed and one-half of the samples were stored at 35° F. and the remainder at 90° F. for the first four months and then at 100° F. for the remainder of the storage period.

The processing data for the four batches of powder are as follows:

Batch no.	A27	A28	A31	B2
	Composition of Condensed Milk			
Fat, per cent	10.72	10.53	10.33	10.93
Total solids, per cent	40.16	39.14	38.71	41.32

	Drying Data			
Inlet temperature	345° F.	345° F.	345° F.	345° F.
Outlet temperature	185° F.	185° F.	185° F.	185° F.
Nozzle number	58	58	64	58
	Powder Data			
Flavor	Good	Good	Good	Good
Color	Light	Light	Light	Light
Fat, per cent	26.04	25.98	26.25	26.17
Total solids, per cent	97.82	98.00	97.80	97.80
Moisture, per cent	2.18	2.00	2.20	2.20
Copper, p.p.m.	1.23	1.30	1.23	1.20
Iron, p.p.m.	6.3	5.3	4.2	4.7

The colorimetric method of Chapman and McFarlane (2) was used for the determination of fat peroxides using a Coleman Universal Number 11 Spectrophotometer. The authors claim it is more sensitive than iodometric methods.

For the determination of gas content of the headspace gas the method of Van Slyke and Sendroy (15) was used.

All the samples were scored for flavor at various intervals by at least two judges. The samples were scored for flavor within four hours after reconstitution.

Copper was determined by the method of Hetrick and Tracy (8) and iron was determined by the method of Pyenson and Tracy (12).

EXPERIMENTAL RESULTS

Changes in carbon dioxide concentration in headspace gas. Figure 1 shows the changes of carbon dioxide content of the headspace gas in the four samples over a period of one year. The production of carbon dioxide throughout the storage period was not uniform. Carbon dioxide is probably produced as the storage period of the powder progresses but is likely reabsorbed in some cases resulting in variable results.

The samples stored at 35° F. produced less carbon dioxide than those stored at 100° F. The greatest amount of carbon dioxide was produced in the air-packed samples stored at 100° F. The least carbon dioxide was produced in the nitrogen-packed samples stored at 35° F. The headspace gases varied in carbon dioxide from none to 0.61 per cent.

Changes in oxygen concentration in headspace gas. Figure 2 gives the data for the change in the percentage of oxygen in the headspace gas of both the air-packed and nitrogen-packed samples. Sixteen hours after packing and gassing the samples had the following analysis for oxygen:

Sample No.	*Per cent oxygen in headspace*	
	Air pack	*Nitrogen pack*
A27	20.84	2.43
A28	20.83	1.61
A31	20.81	2.05
B 2	21.05	1.88

It is a well-known fact that powdered milk on storage will show a reduction of oxygen in the headspace, the amount of change depending on a number of factors in the manufacture, packing and storage of the powder. The four commercial batches of whole milk powder used in these experiments were not packed directly from the drier but varied in age from 9 to 14 days at the time of packaging. From the results obtained in comparison with other experimental data the reduction in percentage of oxygen is not as great in the headspace gas of powder packaged cold as in powder packaged directly from the drier (3, 7).

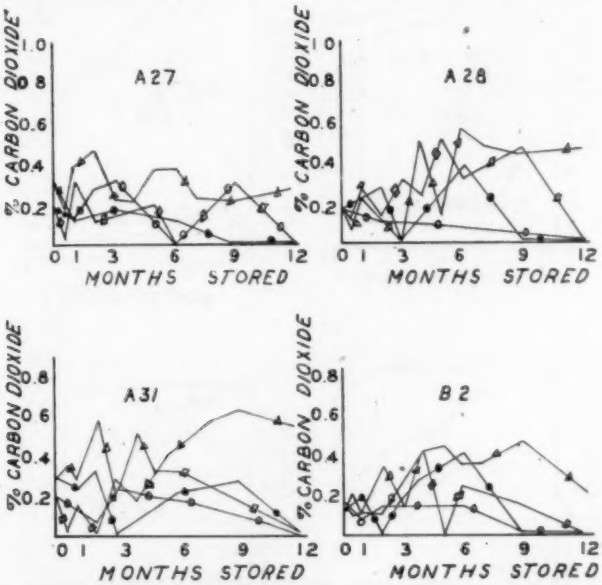

FIG. 1. Effect of storage on the carbon dioxide content of the headspace of spray dried whole milk powder. Legend to curves: ● air-packed stored at 35° F. ○ nitrogen-packed stored at 35° F. △ air-packed stored at 100° F. □ nitrogen-packed stored at 100° F.

The air-packed samples stored at 35° F. showed a good deal less oxygen absorption than the air-packed samples stored at 100° F. The maximum absorption at 35° F. was 3.59 per cent with an average absorption of 2.85 per cent oxygen. At the higher storage temperature there was a maximum drop of 9.98 per cent oxygen in the headspace with an average drop of 7.65 per cent oxygen for the four samples. There was approximately 2.7 times as much oxygen absorbed at 100° F. as at 35° F. after 12 months storage.

In the nitrogen-packed samples there was a similar trend in absorption between low and high temperature of storage. At 35° F. the nitrogen-

packed samples averaged only 0.37 per cent oxygen reduction while at 100° F. there was an average reduction of 1.24 per cent of oxygen in 12 months. There was approximately 3.3 times as much oxygen absorbed at 100° F. than at 35° F. in the nitrogen-packed samples.

Changes in peroxide values. Peroxide values (expressed as milliequivalents of peroxide per kilogram of milk powder) were determined on the four samples of whole milk powder at frequent intervals throughout the storage

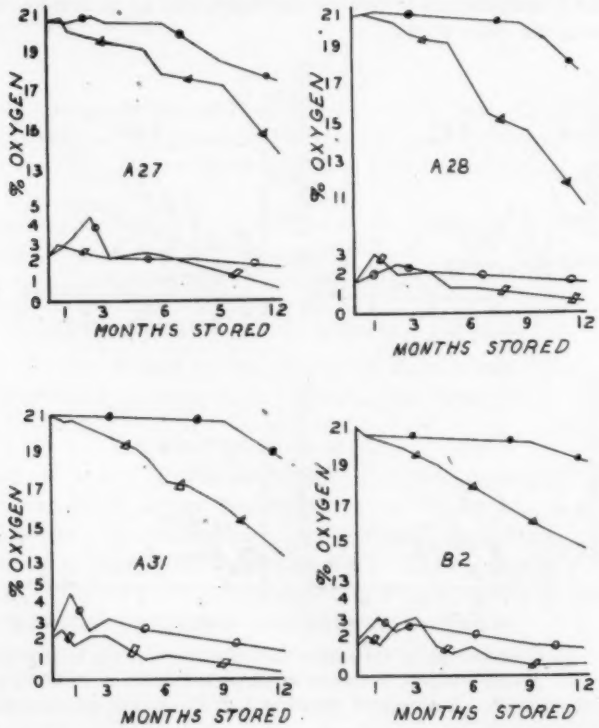

FIG. 2. Effect of storage on the oxygen content of the headspace of spray dried whole milk powder. Legend to curves: Same as in Fig. 1.

period. It will be noted in figure 3 that all the samples had a peroxide value at the first determination except B2 stored at 35° F. and 100° F.

For the first three months of storage the peroxide values remained fairly low, fluctuating from 0 to 10 milliequivalents of peroxide per kilogram of milk powder. At four months storage, in most cases, the peroxide content increased sharply and reached a maximum at six to nine months. After nine months of storage the peroxide values started to decline and at twelve

months most of the samples reached low values. On the whole these values were not as low as those recorded for the first three months of storage.

There seemed to be no significant differences in peroxide values between cold or hot storage or between air- and nitrogen-packed samples of the same powder at the same storage period. At 100° F. there was a tendency for the peroxide values of the whole milk powder to remain at the maximal or near the maximal values for a longer period of time than those peroxides produced at 35° F. It is noted from figure 3 that there was a gradual increase in maximal peroxide values as the age of the powder increased from

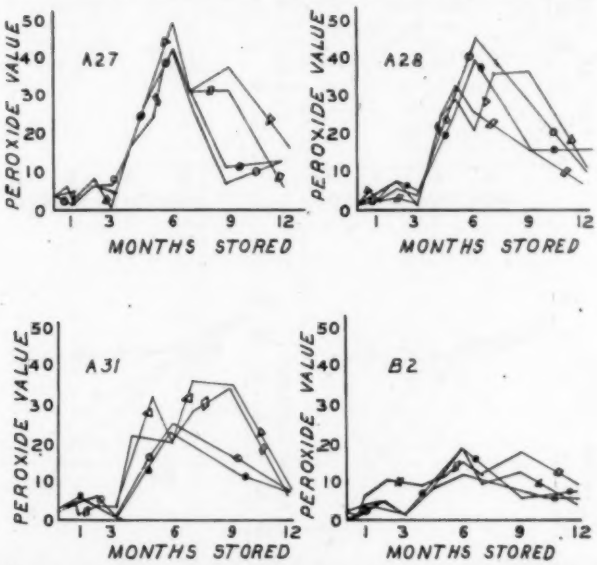

FIG. 3. Effect of storage on the peroxide value (milliequivalents of peroxide per kilogram of milk powder) of spray-dried whole milk powder. Legend to curves: Same as in Fig. 1.

9 to 15 days before gas-packing. The highest peroxide value was obtained on sample A27 which was air-packed and held at 100° F. for six months.

Changes in flavor on storage. Whole milk powder that becomes oxidized seems to go through a certain number of preliminary changes in flavor on storage. A freshly prepared sample of whole milk powder will usually have a cooked flavor. As the period of storage increases a stale flavor usually develops. Sometimes a bitter off flavor may develop, followed by a metallic flavor, particularly in the case of powder stored at a low temperature. The four samples of powder studied here under various conditions of packing and storing went through a series of flavor changes. Not all of the samples

developed every one of the off flavors mentioned but they all acquired an oxidized flavor before the end of the study.

Figure 4 shows that the powder stored under nitrogen at 35° F. kept the best, followed by air-packed at 35° F., nitrogen-packed at 100° F. and then air-packed at 100° F. Air-packed samples stored at 35° F. kept better

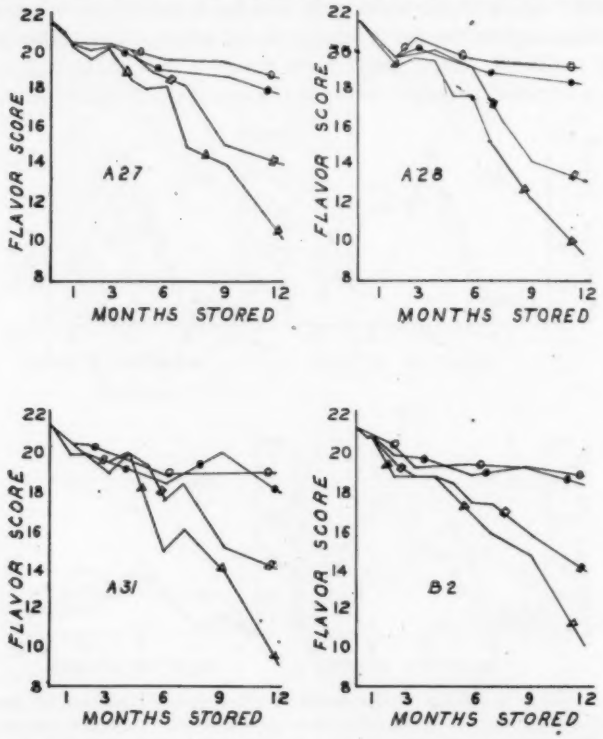

FIG. 4. Effect of storage on the flavor score of spray-dried whole milk powder. Legend to curves: Same as in Fig. 1.

than nitrogen-packed samples stored at 100° F. In every case nitrogen-packed samples kept better than the equivalent air-packed samples.

Relation of peroxide value and flavor. A comparison of figures 3 and 4 show that there is no correlation between peroxide value and flavor score in either air- or nitrogen-packed samples stored at either 35° F. or 100° F. After the oxidized flavor developed the defect became progressively worse as the storage period lengthened but the peroxide values did not increase accordingly. The relation between oxidized-flavor development and peroxide value is summarized in table 1.

It will be noted from table 1 that some of the samples did not have an oxidized flavor when the greatest amounts of peroxide were present. The oxidized flavor did not develop in some of the samples until the peroxide value had fallen to a low figure after reaching its maximum. This would indicate that the oxidized flavor may be due to decomposition products formed after the peroxides occur and is not due to peroxide accumulation.

TABLE 1

Relation between oxidized flavor development and peroxide value

Sample*	Month oxidized flavor first noted	Peroxide value when oxidized flavor first noted	Month maximum value reached	Maximum peroxide value obtained	Flavor score at 1 yr. old	Peroxide value at 1 yr. old
A27035	12	13.1	6	42.8	17.5	13.1
A27135	12	13.4	6	42.8	18.5	13.4
A270100	4	17.7	6	48.8	10.0	16.6
A271100	5	23.9	6	42.8	14.0	5.7
A28035	12	17.2	6	39.7	18.0	17.2
A28135	12	10.3	6	46.4	19.0	10.3
A280100	5	28.8	9	36.3	9.0	11.7
A281100	6	24.9	9	42.0	13.0	7.5
A31035	6	23.5	6	23.5	18.0	8.3
A31135	6	25.2	6	25.2	19.0	7.0
A310100	5	32.8	9	36.7	9.0	7.9
A311100	6	20.2	9	34.5	14.0	6.6
B2035	6	18.9	6	18.9	18.5	7.6
B2135	6	12.6	6	12.6	19.0	6.9
B20100	6	15.4	9	18.6	10.0	9.6
B21100	6	18.8	6	18.8	14.0	4.4

* Key to samples: Fist letter and two numerals are sample numbers. Next numeral stands for air-packed (0) or nitrogen-packed (1). The last two or three numerals are storage temperature. 35 for 35° F. and 100 for 100° F.

DISCUSSION

Although the spectrophotometric method may be more sensitive than other methods for the determination of fat peroxides in whole milk powder, and gives higher results than iodometric methods (2) there still are some limitations in the measurement of peroxides by this procedure.

In the course of this study a number of factors arose that may or may not be important in determining peroxides in dry whole milk by this method. They may be listed as follows:

1. The dry whole milk is extracted by direct treatment with acetone. This procedure may not extract all of the butterfat. Lea, Moran and Smith (11) state, "The amount of fat which can be extracted from spray-dried full-cream milk powder by direct treatment with solvents is only a small proportion (ca. 3–14%) of that present, although in the case of the roller-dried powder extraction is almost complete (92–96%)."

2. Refluxing of the sample for 20 minutes at 65–70° C. may decompose

the fat peroxides and the unstable peroxides may decompose before extraction is accomplished and the determination made.

3. The size of the sample used in the method is only 200 milligrams and may not be representative.

4. Small changes in concentration of the water during the preparation of the sample may give false results.

5. Acetone precipitates some of the phospholipid material during the extraction. This phospholipid material left behind may be just as important in peroxide and oxidation development as the extracted fat.

From this study it is apparent that the major problem encountered in any method for the determination of peroxides in dry whole milk is the ability to extract the butterfat from the powder without changing it chemically. In work with pure butterfat this problem is not important as the butterfat has been extracted from the material before the peroxides have begun to develop. In dry whole milk powder where the fat is intimately associated with the milk solids-not-fat the problem of removing the fat without any chemical changes taking place is a difficult one. The phospholipid material associated with the fat should also be extracted for the determination as there is no definite proof that this substance is not associated with oxidative changes on storage.

Mechanical methods of extraction of the butterfat and phospholipid material have not been tried, but further investigations may show that some such procedure may be preferable for preparing the sample for analysis.

SUMMARY

One-hundred-gram samples of four different lots of powdered whole milk were stored at 35° and 100° F. for a period of one year. Half the samples were air-packed and the remainder were nitrogen-packed. Determinations were made periodically of the oxygen and carbon dioxide present in the headspace gas. Peroxide values were also measured and the reconstituted milk was judged for flavor. Summarized results follow:

1. The amount of carbon dioxide evolved during storage was not uniform, suggesting that this gas is reabsorbed to some extent by certain constituents of the milk. Higher carbon dioxide values were obtained on the samples stored at 100° F.

2. After twelve months storage there was approximately 2.7 times as much oxygen absorbed at 100° F. as at 35° F. in the air-packed samples. In the nitrogen-packed samples there was approximately 3.3 times as much oxygen absorbed at the higher storage temperature.

3. Most of the freshly packed samples showed some peroxide value though a number of these samples did not develop an oxidized flavor until after nine months of storage.

4. Although fluctuating peroxide values were obtained on the same lot

of powder during storage, in general, maximum values were reached in 6 to 9 months, after which the trend was downward.

5. There was no correlation between peroxide value and either the temperature of storage or the method of packing the powder.

6. The flavor score of all samples decreased during storage but at a more rapid rate in the case of the air-packed samples and those samples held at 100° F.

7. Although peroxide formation in all samples was higher after 12 months of storage, the values were not sufficiently correlated with flavor scores to justify the use of the peroxide test as a means of measuring or predicting the keeping quality of whole milk powder.

8. Organoleptic tests remain the most accurate method of measuring changes that occur in flavor and odor of powdered whole milk during storage at either 35° F. or 100° F.

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SOME PHYSIOLOGICAL EFFECTS OF EXTENDING THE COLOSTRUM FEEDING PERIOD OF DAIRY CALVES

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Within recent years considerable attention has been given to the value of colostrum as a feed for newborn animals. The Associates of Rogers (2) have reviewed the work relating to the immunizing properties of colostrum in protecting the young animal against various infective organisms common to the environment of the newborn calf. There are, however, in addition to these immunizing agents, other factors of similar importance in the nourishment of the newborn. Vitamin A is one of these factors that has received some investigational attention.

In 1933 Dann (4) reported that colostrum was many times as potent in vitamin A as normal milk. This finding has been adequately substantiated by other workers (6, 12, 13, 14, 15). The importance of vitamin A in the nutrition of the newborn calf has been shown (8, 11) and the value of colostrum in supplying this vitamin to the calf investigated. The newborn calf has a low vitamin A reserve—as measured by the carotene and vitamin A content of the liver (7) and blood plasma (8, 10). Colostrum is the natural source of vitamin A and carotene for the newborn animal. In the normal calf the amount of vitamin A and carotene in the blood rapidly increases following the ingestion of colostrum. In some instances, calves have apparently failed to respond to colostrum feeding (10). In others, either because of an insufficient quantity of vitamin A in the dam's colostrum, a failure to consume sufficient colostrum, or a failure to respond to colostrum feeding, benefit has been derived from direct vitamin A supplementation (8, 11).

The average dairy cow usually produces much more colostrum than her calf can consume. This colostrum, even that from cows on winter feed, is an important and perfectly adapted source of vitamin A, as well as of other essential factors for the young calf. Yet, on most dairy farms the colostrum not nursed by the calf is wasted or used for feeding purposes in which the greatest benefits from the vitamin A and other factors are not obtained. Allen (1) used stored colostrum to replace marketable milk in the feeding of calves. He found that colostrum could be stored in a frozen condition for as long as a year and still be entirely satisfactory as a substitute for marketable milk in calf raising.

The investigation presented in this report was undertaken to determine the effects of extending the colostrum feeding period to 7 days on the blood-

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plasma carotene, vitamin A, and ascorbic acid levels and on the health and general performance of dairy calves.

EXPERIMENTAL

Experimental animals. Thirty-six dairy calves born in The Ohio State University Dairy Herd during the winter feeding period of 1944–1945 were used in this experiment. Four dairy cattle breeds were represented as follows: 8 Ayrshire, 8 Guernsey, 8 Jersey and 12 Holstein-Friesian. Since all of the calves in The Ohio State University Dairy Herd were being used on a large-scale experimental test to determine the value of a commercial vitamin capsule in the prevention of calf scours, four groups were planned as follows:

Group I. Calves in this group were to receive colostrum for the usual period (3 days) plus a placebo capsule for the first 21 days.

Group II. These calves were to receive colostrum for 7 days plus a placebo capsule for 21 days.

Group III. Calves in this group were to receive colostrum for 3 days plus a vitamin capsule for 21 days.

Group IV. These calves were to receive colostrum for 7 days plus a vitamin capsule for 21 days.

The vitamin capsule used in this experiment contained 10,000 International Units of vitamin A, 300 U.S.P. Units of vitamin D, 50 milligrams niacin and 250 milligrams of ascorbic acid.

As calves were born they were assigned to a group following a definite order so that there was equal breed representation in each group. Thus, each group finally consisted of 2 each of the Ayrshire, Guernsey and Jersey breeds and 3 of the Holstein-Friesian breed. The original plans were to leave the calf with the dam for the first 3 days and to obtain the colostrum not nursed by the calf by milking for storage and later feeding. After 3 days the calf was to be weaned and fed whole milk or stored colostrum as the case might be, depending on the group to which the calf was originally assigned at birth. After 2 calves had been assigned to each group this plan was modified because a truly representative composite sample of colostrum for vitamin A and carotene determination could not be obtained from a cow being nursed by a calf and the colostrum intake of the calf could not be accurately determined.

The remaining 28 calves in the experiment were therefore taken from the dam immediately after they were dropped and fed from a nipple pail. They received colostrum from their own dam for the first 3 days, after which they received mixed Holstein milk or stored colostrum, depending upon the group to which they were assigned. The stored colostrum was usually a mixture from several cows, therefore in calculating the vitamin A and carotene intake of the colostrum-fed calves from the fourth to the seventh day the aver-

age potency of the colostrum from the entire group of cows was used. The potency values of the colostrum from cows which were nursed (8 cows) and those which had milk fever (3 cows) were not used in determining this average potency because of the inability to obtain reliable representative samples as previously pointed out. Data on the potency of the colostrum fed to the calves in this experiment are reported in a previous paper (15). The potency values for average mixed Holstein milk produced during the winter months were used in determining the vitamin A and carotene intake of the milk-fed calves from the fourth to the seventh day. These potency values for the colostrum fed from the fourth to seventh day, inclusive, were: vitamin A, 821 micrograms; and carotene, 893 micrograms per pound; for the milk, the potency values were 126 micrograms of vitamin A and 143 micrograms of carotene per pound. The colostrum or milk was fed at the rate of one pound for each 10 pounds of body weight.

Techniques. All the calves were bled by puncturing the jugular vein before they nursed or were fed colostrum (2 exceptions) and on the 3rd, 5th, 7th, 9th, 11th, and 14th day of age, and 24 of the calves were bled when 21 days of age. A 30-ml. sample was drawn into a brown glass bottle containing 0.5 ml. of a 20 per cent potassium oxalate solution. The blood samples were taken to the laboratory immediately and in the majority of cases the determinations were completed within 4 hours.

Blood-plasma vitamin A and carotene were determined by the method of Kimble (5); ascorbic acid was determined by the macro method of Mindlin and Butler (9). The vitamin A and carotene in the colostrum fed were determined by the method of Boyer, *et al.* (3).

An Evelyn Photoelectric Colorimeter with the appropriate filters for each determination was used. The instrument previously had been standardized against crystalline vitamin A alcohol in chloroform solution, crystalline beta carotene in petroleum-ether solution, and ascorbic acid crystals in 3 per cent meta-phosphoric acid solution.

The calves were fed colostrum or milk at the rate of one pound daily for each 10 pounds of body weight and were weighed daily for the first 14 days. After reaching approximately 2 weeks of age, hay was available to the calves at all times.

EXPERIMENTAL RESULTS

Vitamin A intake. Data on the vitamin A intake of the calves used in this experiment are presented in tables 1 and 2. Table 1 shows the vitamin A and carotene intake from the colostrum alone in terms of micrograms. These intakes are reported as totals for the first 3 days and the next 4 days, because during the first 3 days all calves received colostrum from their dams and during the next 4 days those in groups II and IV received mixed stored colostrum and groups I and III received mixed milk.

TABLE 1

The vitamin A and carotene intake (from colostrum) of the calves during the first 7 days of the experiment

Quantities expressed in micrograms

Calf No.‡	1st 3 days		4th–7th days incl.		Total for first 7 days	
	Vitamin A*	Carotene	Vitamin A*	Carotene	Vitamin A*	Carotene
Group I: Control, colostrum 3 days—placebo capsule 21 days						
310A	13,512	14,708	4,032	4,576	17,544	19,284
314A	13,107	14,362	3,528	4,004	16,635	18,366
291G†	11,755	26,341	3,528	4,004	15,283	30,345
298G	8,790	21,000	3,024	3,432	11,832	24,432
449H†	17,843	15,489	4,032	4,576	21,875	20,065
459H	15,301	14,013	4,356	5,148	19,657	19,161
463H	17,050	15,320	5,020	5,720	22,070	21,040
330J	18,273	14,035	3,528	4,004	21,801	18,039
335J	9,042	9,672	3,024	3,432	12,066	13,104
Average	13,854	16,104	3,786	4,322	17,640	20,426
Group II: Experimental, colostrum 7 days—placebo capsule 21 days						
309A	36,640	29,612	32,840	35,720	69,480	65,332
313A	22,992	20,456	26,272	28,596	49,264	49,052
290G†	11,755	26,341	26,272	28,596	38,027	54,937
296G	12,750	31,650	19,704	21,432	32,454	53,082
450H†	17,843	15,489	25,451	27,683	45,294	43,172
457H	15,730	16,160	32,840	35,720	48,570	51,880
465H	24,300	22,102	32,840	35,720	57,140	57,822
329J	18,736	33,904	26,272	28,596	45,008	62,500
334J	21,405	16,801	22,988	25,004	44,393	41,805
Average	20,239	23,613	27,287	29,674	47,528	53,287
Group III: Experimental, colostrum 3 days—vitamin capsule 21 days						
308A	14,536	10,608	4,032	4,576	18,568	15,184
312A	9,208	5,712	3,528	4,004	12,736	9,716
293G	11,008	28,008	3,654	4,147	14,662	32,155
295G	15,960	26,092	2,016	2,288	17,976	28,380
448H†	17,843	15,489	4,032	4,576	21,875	20,065
461H	25,197	20,647	5,522	6,297	30,701	26,939
464H	11,041	3,758	4,032	4,576	15,072	8,334
327J†	15,869	17,667	3,528	4,004	19,397	21,671
332J	8,178	11,808	3,024	3,432	11,202	15,240
Average	14,314	15,532	3,708	4,211	18,021	19,743
Group IV: Experimental, colostrum 7 days—vitamin capsule 21 days						
307A	32,784	11,080	26,272	28,596	59,056	39,676
311A	15,714	16,128	29,556	32,148	45,270	48,276
292G	14,240	33,424	25,451	27,683	39,691	60,107
294G	7,784	17,872	19,704	21,432	27,488	38,304
451H†	17,843	15,489	26,272	28,576	44,115	44,061
455H	19,980	18,540	31,198	33,934	51,176	52,474
460H	12,160	13,370	32,840	35,720	46,210	47,880
328J†	15,869	17,667	22,988	25,004	38,957	42,671
331J	19,581	19,781	21,246	23,218	40,827	44,163
Average	17,328	18,105	26,170	28,479	43,498	46,629

* The figures in this table represent only the vitamin A intake from colostrum alone in terms of micrograms and does not include the vitamin A administered by capsule.

† These calves nursed the first three days and their carotene and vitamin A intake was estimated by assuming a daily consumption of 1 lb. per 10 lbs. body weight with a potency of the average of the group of cows used in the experiment.

‡ The letter following the calf number indicates the breed, *e.g.*: A = Ayrshire.

It will be noted that there is a rather wide variation in the vitamin A and carotene intake from colostrum during the first 3 days. This arises from the fact that in addition to some variation in weight of the calves there was considerable variation in the potency of the colostrum produced by the individual cows. As a group, the calves in group II had the highest intake of carotene and vitamin A because the cows in this group produced colostrum that averaged higher in potency than that of the other groups.

It should be pointed out, that in the entire group of 36 calves the lowest vitamin A intake from colostrum during the first 3 days was 47,432 International Units and the average was 96,300, or a minimum daily intake of 15,610 and an average of 32,100 International Units. Considering that those calves were all born during the winter feeding period, the majority of them during January, February and March, the amount of vitamin A supplied to the calf through the colostrum is impressive.

From the fourth to the seventh day the intake of vitamin A and carotene from mixed colostrum in Groups II and IV are quite similar; also, the intake from mixed Holstein milk in groups I and III are much alike. Since the same potency figures were used in calculating the intake from colostrum in the former and from milk in the latter groups, the differences recorded arise from differences in the weight of the calves. Although the method of calculating these intakes is subject to criticism because of the lack of preciseness, the use of mixed colostrum and mixed milk for feeding during this period would tend to eliminate much of the irregularity that existed between the individual calves during the first 3 days when each calf was fed colostrum from its own dam.

Table 2 shows the total vitamin A intake of the individual calves and the average for each of the groups in International Units. This unitage was arrived at as follows: Micrograms of vitamin A (table 1) $\times 4$ + micrograms of carotene (table 1) $\times 1.66$ + 10,000 International Units daily from the capsule fed to groups III and IV.

It will be noted that the difference in the average total intake between groups I and III is almost exactly the amount administered by capsule (70,000 I.U.). A similar difference should have occurred between groups II and IV had the dams produced colostrum of comparable potency; however, as mentioned previously, the cows represented in group II produced colostrum having a higher average potency than those of the other groups. This materially reduced the difference in intake between the calves of groups II and IV.

The blood picture. The vitamin A, carotene, and ascorbic acid changes in the blood plasma of the individual calves are presented in tables 3, 4, and 5 and summarized in table 6.

It will be noted that the calves had extremely low levels of vitamin A in the blood plasma at birth. This substantiates the finding of Lundquist and

TABLE 2

Total vitamin A intake of the calves during the first 7 days of the experiment
Results expressed as International Units*

Calf No.	1st 3 days	4th to 7th days inclusive	Total for 7-day period
Group I: Control, colostrum 3 days + placebo capsule 21 days			
310A	78,561	23,755	102,316
314A	77,444	19,605	97,049
291G	90,922	19,605	110,527
298G	70,160	17,888	88,048
449H	97,350	23,755	121,105
459H	84,559	26,004	110,563
463H	93,733	29,613	123,346
330J	97,563	19,605	117,169
335J	52,288	17,888	70,176
Average	82,508	21,969	104,478
Group II: Experimental, colostrum 7 days + placebo capsule 21 days			
309A	193,913	190,893	386,806
313A	126,064	152,748	278,812
290G	90,922	152,748	243,670
296G	103,750	114,536	218,286
450H	97,350	147,942	245,292
457H	89,753	190,893	260,646
465H	134,033	190,893	324,926
329J	131,510	152,748	284,258
334J	113,636	133,625	247,261
Average	117,711	159,666	278,775
Group III: Experimental, colostrum 3 days + vitamin capsule 21 days			
308A	105,824	63,755	169,579
312A	77,432	59,605	137,037
293G	120,712	61,527	182,239
295G	136,326	51,877	188,203
448H	127,350	63,755	191,105
461H	165,121	72,574	237,695
464H	80,423	63,755	144,178
327J	122,921	58,602	181,526
332J	82,392	57,888	140,280
Average	113,167	61,482	174,649
Group IV: Experimental, colostrum 7 days + vitamin capsule 21 days			
307A	179,602	192,748	312,350
311A	119,736	211,804	331,540
292G	142,667	187,942	330,609
294G	90,923	154,536	245,459
451H	127,350	197,748	325,098
455H	140,820	221,349	362,169
460H	100,923	230,893	331,816
328J	122,921	173,615	296,536
331J	141,292	163,681	314,973
Average	129,292	192,695	322,277

* International Units of Vitamin A reported in this table were obtained as follows: (a) Micrograms of vitamin A (Table I) $\times 4.0$; (b) Micrograms of Carotene (Table I) $\times 1.66$; (c) 10,000 I.U. daily from the vitamin capsule in groups III and IV; (a) + (b) + (c) = total International Units.

TABLE 3

The effect of colostrum and vitamin capsule feeding on the blood-plasma vitamin A of calves

Results expressed in micrograms per 100 ml. plasma

Calf No.	Age of calf in days							
	0	3	5	7	9	11	14	21
Group I: Control, colostrum 3 days + placebo capsule 21 days								
310A	6.1	19.6	14.5	18.3	15.7	20.0	15.5	16.8
314A	6.2	27.8	23.2	12.8	15.9	15.5	15.9	11.2
291G	3.5	18.0	14.4	14.2	14.4	13.9	.....	.....
298G	5.6	10.1	9.6	7.0	7.1	9.1	7.2	5.4
449H	4.8	16.3	10.1	.....	14.2	10.1	10.7	.....
459H	4.3	12.9	9.3	12.2	10.6	9.9	11.6	9.4
463H	3.5	12.8	13.0	13.2	14.6	13.3	11.4	9.1
330J	1.7	22.1	9.5	8.4	9.3	9.7	12.4	8.1
335J	4.4	18.9	13.1	10.9	9.2	15.2	13.7	8.5
Group II: Experimental, colostrum 7 days + placebo capsule 21 days								
309A	6.3	28.8	19.9	24.1	14.8	14.7	14.3	12.8
313A	6.3	5.3	13.1	20.4	12.1	11.2	15.7	9.5
290G	2.1	13.7	20.8	12.7	19.9	11.8	9.5	.....
296G	1.9	10.1	13.4	9.7	9.4	8.6	9.9	11.8
450H	9.4	18.3	15.2	16.0	12.6	9.9	12.3	.....
457H	4.9	25.8	22.9	22.2	16.4	13.5	10.8	14.8
465H	5.0	13.6	20.9	18.1	21.3	18.1	13.2	11.9
329J	7.3	15.8	18.0	16.5	16.7	13.2	12.0	.....
334J	4.5	20.4	25.7	31.1	18.2	17.3	13.9	14.2
Group III: Experimental, colostrum 3 days + vitamin capsule 21 days								
308A	3.7	19.3	17.2	17.0	16.8	22.3	20.0	21.6
312A	3.8	12.6	12.7	11.9	15.9	13.3	17.2	12.8
293G	3.1	15.0	14.1	12.8	10.4	9.4	15.3	.....
295G	2.3	15.9	12.8	10.8	12.0	11.2	15.7	13.1
448H	6.5	14.3	.....	13.9	11.7	16.6	10.1	.....
461H	3.9	16.8	11.1	10.6	11.0	12.8	12.2	10.6
464H	4.3	14.1	10.3	9.3	12.5	7.6	12.6	8.7
327J	5.9	16.0	13.5	18.2	18.5	18.7	10.4	.....
332J	4.4	17.3	9.0	11.4	8.3	11.8	14.6	9.3
Group IV: Experimental, colostrum 7 days + vitamin capsule 21 days								
307A	3.7	23.3	27.7	27.9	20.1	19.8	19.2	14.1
311A	6.2	26.1	20.8	31.3	21.9	20.3	22.5	17.5
292G	4.4	18.7	15.1	13.8	14.4	10.7	16.9	.....
294G	3.4	15.4	13.0	19.3	17.7	9.2	11.1	12.1
451H	9.0	16.8	21.5	24.3	15.1	12.2	10.6	.....
455H	2.2	20.4	24.7	27.5	21.5	17.2	14.6	.....
460H	5.1	16.7	16.1	15.3	10.3	11.8	10.5	13.0
328J	2.2	16.2	13.9	16.5	13.4	18.6	14.9	.....
331J	2.1	15.7	17.8	20.1	15.3	12.0	17.7	10.9

Phillips (8) and Moore and Berry (10). The ingestion of colostrum results in a rapid increase in the amount of this vitamin in the blood as others (8, 10) have noted. Similar changes are noted in the case of carotene.

The results reported in tables 3, 4, and 6 also show the effects of extending the colostrum feeding period to 7 days on the blood-plasma vitamin A

TABLE 4

The effects of colostrum and vitamin capsule feeding on the blood plasma carotene of calves

Results expressed in micrograms per 100 ml. plasma

Calf No.	Age of calf in days							
	0	3	5	7	9	11	14	21
Group I: Control, colostrum 3 days + placebo capsule 21 days								
310A	8.3	22.8	16.9	14.0	14.0	16.9	16.9	42.8
314A	6.9	18.4	16.2	14.0	11.1	16.9	16.9	16.9
291G	6.2	105.5	79.0	75.1	79.0	86.1	.....	.....
298G	6.2	55.1	51.0	25.8	14.0	25.8	18.4	19.8
449H	8.3	16.9	11.2	10.5	14.0	11.2	8.3	.....
459H	9.7	22.8	22.8	28.1	25.8	25.1	31.8	21.4
463H	6.9	14.0	11.1	8.3	8.3	11.1	14.0	15.5
330J	14.0	31.8	19.8	14.0	21.3	16.9	19.8	19.8
335J	14.0	28.8	31.0	21.4	15.5	22.1	21.3	19.8
Group II: Experimental, colostrum 7 days + placebo capsule 21 days								
309A	5.5	28.8	41.2	31.8	24.3	28.8	34.9	34.9
313A	5.5	5.5	15.5	11.1	14.0	11.2	14.0	19.8
290G	8.3	67.0	88.0	126.4	101.5	117.8	109.0	.....
296G	11.2	75.1	71.5	17.7	16.9	22.9	34.9	73.2
450H	16.9	19.8	27.3	37.4	38.1	34.9	37.4	.....
457H	5.5	25.8	49.3	54.3	49.3	47.7	44.4	38.9
465H	4.2	34.9	54.3	31.8	21.4	22.8	28.8	27.3
329J	11.1	34.9	47.7	69.7	44.5	28.8	25.8	.....
334J	2.8	44.2	51.0	56.8	61.0	51.0	51.9	57.6
Group III: Experimental, colostrum 3 days + vitamin capsule 21 days								
308A	4.1	16.9	14.0	16.9	19.8	16.9	16.9	28.8
312A	2.8	16.9	25.8	6.9	11.2	6.9	8.3	14.0
293G	11.1	47.5	61.0	57.6	28.8	31.8	54.3	.....
295G	5.5	28.1	34.9	22.8	25.8	38.1	31.8	52.6
448H	8.3	24.3	39.9	17.7	19.8	12.6	16.9	.....
461H	0.0	19.8	18.4	15.3	14.0	14.0	12.6	14.0
464H	5.5	5.5	8.3	2.8	7.6	6.9	16.9	6.9
327J	11.2	31.8	22.8	22.1	16.9	25.8	8.3	.....
332J	13.3	23.2	17.7	14.0	16.9	8.3	8.3	8.3
Group IV: Experimental, colostrum 7 days + vitamin capsule 21 days								
307A	4.1	14.0	19.8	51.0	51.0	42.8	41.2	38.1
311A	3.9	19.8	28.8	28.8	34.9	36.5	39.7	31.8
292G	14.0	71.5	34.9	19.8	54.3	45.2	41.2	.....
294G	8.3	41.2	31.0	51.0	52.6	25.8	17.7	18.4
451H	6.9	19.1	17.7	22.8	22.8	22.8	19.8	.....
455H	5.5	22.8	41.2	84.2	65.3	59.3	53.4	.....
460H	3.5	21.4	30.3	16.9	8.3	8.3	10.4	11.2
328J	5.5	50.9	62.7	57.6	60.1	64.5	54.3	.....
331J	8.3	36.5	38.1	28.0	42.8	25.8	28.8	19.8

and carotene. When the colostrum feeding period is extended, both the vitamin A and carotene continue to rise, reaching a peak on the 7th day, and the decline following the shift to milk feeding is more gradual. As would be expected when both additional colostrum and a vitamin capsule are provided, the highest level of blood-plasma vitamin A was attained and main-

TABLE 5

The blood plasma ascorbic acid of calves used in this experiment
Results expressed in milligrams per 100 ml. of plasma

Calf No.	Age of calf in days							
	0	3	5	7	9	11	14	21
Group I: Control, colostrum 3 days + placebo capsule 21 days								
310A	0.46	0.37	0.35	0.39	0.35	0.20	0.39	0.37
314A	0.67	0.52	0.50	0.62	0.41	0.50	0.44	0.36
291G	0.82	0.70	0.70	0.72	0.64	0.52	0.23	.....
298G	1.30	0.71	0.64	0.64	0.48	0.42	0.47	0.29
449H	0.76	0.65	0.33	0.31	.....	0.32	0.23	.....
459H	1.23	0.60	0.61	0.38	0.47	0.40	0.36	0.42
463H	1.11	0.41	0.52	0.50	0.41	0.47	0.38	0.40
330J	1.23	0.73	0.41	0.49	0.49	0.38	0.33	0.31
335J	1.11	0.38	0.49	0.49	0.49	0.38	0.42	0.36
Group II: Experimental, colostrum 7 days + placebo capsule 21 days								
309A	0.70	0.49	0.53	0.50	0.37	0.44	0.45	0.35
313A	0.66	0.21	0.25	0.39	0.31	0.18	0.16	0.26
290G	0.78	0.44	0.44	0.58	0.47	0.65	0.49	.....
296G	.....	0.49	0.63	0.38	0.23	0.40	0.42	0.28
450H	0.49	0.43	0.44	0.44	0.35	0.32	0.28	.....
457H	0.66	0.59	0.53	0.41	0.49	0.35	0.41	0.33
465H	0.88	0.69	0.45	0.50	0.53	0.49	0.48	0.39
329J	1.67	0.73	0.44	0.61	0.48	0.44	0.42	.....
334J	0.82	0.46	0.39	0.38	0.38	0.36	0.53	0.38
Group III: Experimental, colostrum 3 days + vitamin capsule 21 days								
308A	1.04	0.79	0.77	0.97	0.63	0.67	0.67	0.60
312A	0.64	0.52	0.46	0.50	0.41	0.39	0.38	0.32
293G	0.62	0.70	0.66	0.60	0.43	0.50	0.38	.....
295G	0.89	0.64	0.58	0.44	0.40	0.38	0.63	0.32
448H	0.70	0.58	0.70	0.57	0.47	0.43	0.29	.....
461H	.....	0.47	0.50	0.55	0.44	0.40	0.30	0.40
464H	0.97	0.38	0.53	0.62	0.55	0.49	0.52	0.32
327J	0.75	0.44	0.40	0.58	0.36	0.41	0.24	.....
332J	0.90	0.35	0.59	0.54	0.50	0.41	0.30	0.26
Group IV: Experimental, colostrum 7 days + vitamin capsule 21 days								
307A	0.72	0.61	0.60	0.67	0.54	0.50	0.49	0.40
311A	0.60	0.49	0.46	0.46	0.39	0.51	0.45	0.31
292G	0.70	0.53	0.53	.....	0.46	0.72	0.43	.....
294G	0.96	0.73	0.67	0.67	0.65	0.74	0.55	0.41
451H	0.93	0.63	0.57	0.53	0.46	0.37	0.36	.....
455H	1.07	0.70	0.52	0.56	0.42	0.41	0.63	.....
460H	0.81	0.66	0.55	0.42	0.33	0.26	0.30	0.30
328J	0.56	0.42	0.31	0.52	0.49	0.54	0.39	.....
331J	0.77	0.48	0.41	0.42	0.41	0.53	0.37	0.24

tained throughout the 21-day period. It is interesting to note that the average vitamin A content of the blood plasma of groups II and III are almost identical on the 21st day. The data in these two groups compare the results obtained when colostrum is fed 7 days (group II) with those obtained when a 10,000 I.U. vitamin A capsule is fed for 21 days (group III).

The data on blood plasma ascorbic acid values substantiates the finding of Lundquist and Phillips (8) that this vitamin is found in the blood of newborn calves at a level considerably higher than that of older calves. The changes following birth, however, were not appreciably affected by the feeding of extra colostrum, a vitamin capsule daily, or a combination of extra colostrum and a vitamin capsule. At the end of the 3-week period the aver-

TABLE 6

Average blood plasma vitamin A, carotene and ascorbic acid values and the average gain in weight of the calves in the experiment, by groups

Group No.	Age of calves in days							
	0	3	5	7	9	11	14	21
	Average blood-plasma vitamin A, γ/100 ml.							
I	4.4	17.6	12.9	12.1	12.3	12.9	12.3	9.8
II	5.3	16.8	18.8	18.9	15.7	13.1	12.4	12.5
III	4.2	15.7	12.6	12.8	13.0	13.7	14.2	12.6
IV	4.2	18.8	18.9	21.7	16.6	14.6	15.3	13.5
	Average blood-plasma carotene, γ/100 ml.							
I	8.9	35.1	28.8	23.5	22.5	25.8	18.5	22.3
II	7.9	37.3	49.5	48.5	41.2	42.3	42.3	41.9
III	6.8	23.8	26.9	19.6	17.8	19.3	19.3	20.8
IV	6.7	33.0	33.8	40.0	43.5	34.0	34.0	23.9
	Average blood-plasma ascorbic acid, mg./100 ml.							
I	0.96	0.56	0.50	0.50	0.47	0.40	0.36	0.36
II	0.83	0.50	0.46	0.47	0.40	0.40	0.40	0.33
III	0.81	0.54	0.57	0.59	0.47	0.45	0.41	0.37
IV	0.79	0.58	0.51	0.53	0.46	0.51	0.44	0.33
	Average gain in weight, lb.							
I	.....	.....	.....	2.6	.....	.....	2.0	.....
II	.....	.....	.....	4.6	.....	.....	3.6	.....
III	.....	.....	.....	1.6	.....	.....	2.4	.....
IV	.....	.....	.....	3.7	.....	.....	1.3	.....

age blood-plasma ascorbic acid was slightly in excess of 0.3 milligrams per 100 ml., which is quite similar to that reported by Lundquist and Phillips (8) for calves over 2 weeks of age.

DISCUSSION

Since, on most dairy farms, the colostrum not nursed by the calf is discarded because it is not marketable, Moore and Berry (10) have suggested that its use in raising calves be studied. Allen (1) has reported that colostrum can be stored (frozen) for a considerable period of time. His work also shows the stored colostrum to be a satisfactory feed for raising dairy calves.

The data reported in this manuscript show the effects of colostrum feed-

ing on the levels of blood-plasma vitamin A, carotene, and ascorbic acid in the dairy calf. When the colostrum feeding period is extended to 7 days, the amount of vitamin A in the blood continues to rise, reaching a peak at 7 days. A comparison of the average data for groups I and II (table 6) show the marked effect of colostrum in this respect. It is felt that this extra colostrum feeding supplies additional vitamin A at a time most critical. The gain-in-weight data in table 6, while not conclusive, strongly indicate beneficial effects on the growth of the calf.

The data from groups II and III compare the effects of 7-day colostrum feeding with the usual (3-day colostrum feeding) scheme plus an additional 10,000 I.U. of vitamin A daily. It should be noted that the extra 4 days of colostrum feeding is an effective substitute for a daily supplement of 10,000 I.U. of vitamin A for the first 21 days. We believe that the evidence is in favor of the colostrum feeding—first, because of the blood vitamin A results which show higher values during the critical early days of the calf's life, and secondly, because the weight-gain data which, though inconclusive, indicate superior growth during the first 2 weeks. It must be remembered in this connection, that the group receiving colostrum for 7 days (group II) had a much higher total solids intake during the first week than did those receiving whole milk after the third day.

A combination of extra colostrum and a vitamin capsule daily (group IV) resulted in the highest level of vitamin A in the blood as would be expected. This may or may not be of significance in the performance of the calf. No data were obtained which indicated superior performance of the calves in this group.

The level of ascorbic acid in the blood was not appreciably changed when extra colostrum, vitamin capsules, or a combination of the two were fed. These data are at variance with those obtained by Lundquist and Phillips (8). It must be remembered, however, that their calves were raised from birth on skim milk, which is probably the reason for the difference in blood-plasma ascorbic acid results.

At the time this experiment was under way a calf in the University Herd was afflicted with navelill. An ascorbic acid analysis of the blood of this calf showed an extremely low value which substantiates the report of Lundquist and Phillips. The feeding of ascorbic acid (approximately 1 gram daily) did not result in the rise in blood-plasma ascorbic acid nor in improvement in the condition of the calf. We do not interpret this as contrary to the results of Lundquist and Phillips, in which the daily injection of 0.5 gm. of ascorbic acid resulted in rapid recovery of calves suffering from navel infections. A more logical interpretation is that the feeding of ascorbic acid is not an effective method for the administration of this vitamin to calves.

During the course of this experiment 15 of the calves showed some evidence of digestive disturbance. These calves had mild to moderate diarrhea.

There were no severe cases. These 15 calves were distributed among the groups as follows: group I, 3; group II, 3; group III, 5; and group IV, 4. Thus 7 were in the groups receiving colostrum for the 7-day period and 8 were in the groups receiving colostrum for the 3-day period. One interesting, and perhaps significant, difference was noted. The calves that received colostrum for 7 days developed diarrhea when they were from 9 to 11 days of age. It is believed that the abrupt change from colostrum to mixed-whole milk may have been a contributing cause. During the time the calves were fed colostrum the calves were housed in warm box stalls and handled by a special caretaker. At the end of their colostrum feeding they were moved to the calf barn where the temperature was considerably lower. A change in caretakers accompanied the move. These conditions may have also contributed to the occurrence of diarrhea. Diarrhea appeared in the calves receiving colostrum for 3 days, when they were from 4 to 11 days of age. This condition developed in 5 of the 8 calves when they were from 4 to 7 days of age. None of the calves in this experiment had scours of the so-called infectious or "white" type.

In 11 of the 15 calves that had diarrhea there was a simultaneous drop in blood-plasma vitamin A and carotene. When the diarrhea cleared up, the blood plasma vitamin A and carotene increased, but did not reach the previous level again; this was to be expected since the general trend in all of the calves was downward. To illustrate: The average level of vitamin A in the blood plasma of these 11 calves preceding the onset of diarrhea was 17.0 micrograms per 100 ml.; during diarrhea, 11.0; and after recovery 14.8 micrograms per 100 ml.

Moore and Berry (10) have pointed out that a blood-plasma response to colostrum feeding is essential to the general health of the newborn calf. His findings, that calves which failed to respond to colostrum were not likely to survive, is substantiated, at least in part, by the performance of calf No. 289G in this experiment. Although this calf had an intake of over 70,000 I.U. of vitamin A during its first 3 days, its blood-plasma vitamin A did not go above 10 micrograms per 100 ml. This calf never performed satisfactorily, and died at approximately 3 months of age.

During the course of this experiment over 650 pounds of colostrum were fed which would otherwise have been wasted. This was not all of the colostrum which was saved during the course of the experiment, but it serves to illustrate the economy of the procedure. Every pound of colostrum saved and used in this way not only is beneficial to the calves being raised but replaces a pound of marketable milk. Under practical dairy-farm conditions it may not be convenient to refrigerate and hold colostrum for feeding according to the plan employed in this experiment. Other plans for its use can no doubt be worked out and adapted to individual dairy farms. A practical experiment to study this point is being planned.

SUMMARY

An experiment designed to study some of the physiological effects of extending the colostrum feeding period was carried out on 36 dairy calves.

In substantiation of the reports of others it was found that calves are born with low reserves of vitamin A but with ascorbic acid reserves considerably above that of later life, as measured by the level of these constituents in the blood plasma.

Blood plasma vitamin A increases rapidly following the ingestion of colostrum. In the calves receiving no other supplement, in this experiment, the average increase amounted to 12.4 micrograms per 100 ml. plasma in the first 3 days. This increase resulted from an average intake of 99,614 International Units of vitamin A from colostrum during the first 3 days.

When the period of colostrum feeding was extended to 7 days the blood-plasma vitamin A continued to increase, reaching a peak on the seventh day. The levels reached on the 7th day averaged 18.9 micrograms per 100 ml. plasma, which was 6.8 micrograms above that of 7-day-old calves which had received colostrum for 3 days.

Calves which received colostrum for 7 days had blood-plasma vitamin A values which averaged almost identically the same at 21 days of age as that of those which received colostrum for 3 days plus a 10,000 I.U. vitamin A capsule daily for the first 21 days.

None of the variations in feeding procedure employed in this experiment appreciably influenced the level of ascorbic acid in the blood plasma.

None of the calves receiving colostrum for 7 days showed any signs of digestive disturbance during the period of colostrum feeding.

Weight records indicate more rapid gains in calves receiving additional colostrum.

The economy of using the colostrum not nursed by the calf for calf feeding purposes is pointed out.

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FORMIC ACID CONTENT OF MILK HEATED TO HIGH TEMPERATURES AS DETERMINED BY THE DISTILLATION PROCEDURE[1]

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In a former study (3), determinations for formic acid were made on the steam distillate from skim milk heated to 116° C. for two hours, using the A.O.A.C. distillation method (1). Results obtained revealed that 80–85 per cent of the total volatile acidity in the distillate was recovered as formic acid when a 20 per cent allowance was made for the incompleteness of recovery by the method used. Thus, these findings indicate formic acid to constitute a large proportion of the volatile acids created when milk is heated at temperatures sufficient to produce lactose decomposition. However, they do not answer the question as to the relative proportion of formic acid to total acidity changes in the milk itself.

Results obtained in two previous papers pertaining to the subject of heat-produced acid in milk (2, 3) reveal the following pertinent facts: (a) lactic acid constitutes not more than 5 per cent of the total titrable acidity produced in milk by heat; (b) the molar destruction of lactose was three times as great as the molar production of titrable acidity expressed as lactic acid; (c) heating of milk at high temperatures creates appreciable quantities of steam volatile acidity, a large share of which is apparently formic acid; (d) the A.O.A.C. method of measuring formic acid does not give quantitative recovery of the acid from an aqueous solution and a correction factor is necessary in order to obtain at least fairly accurate results. A review of earlier research dealing with the production of acid in milk by heat is also presented in these papers.

In view of the fact that the earlier work (3) dealt with formic acid in the steam distillate from heated milk, it appeared desirable to obtain results in which formic acid was determined directly upon the heated milk. Such results serve as the basis for this paper.

PROCEDURE

The formic acid procedure was essentially that recommended by the A.O.A.C. for fruit juices, sirups and jams (1). A 250-ml. sample of milk was used and the volume increased to 300 ml. with 10 ml. distilled water and 40 ml. N H_2SO_4. A small amount of paraffin was added to prevent foaming

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and the sample steam distilled with the vapor passing through 200 ml. of one per cent $BaCO_3$ solution, through a condenser, and into a liter flask. The distillation was continued until one liter of condensate was obtained. The $BaCO_3$ solution containing the volatile acids was then reduced to 100 ml., filtered, and the filtrate treated with sodium acetate, hydrochloric acid and mercuric chloride. The precipitated mercury salt of formic acid was filtered, dried, weighed, and calculated to formic acid.

Heating of the milk was conducted as previously described (2), by using 500-ml. samples in sealed "Cenco" No. 2 cans and heating in the autoclave. The samples were shaken at 30-minute intervals during the heating period.

Titrable acidity of the milk was determined electrometrically, using a glass electrode and a Beckman pH meter and titrating to pH 8.3, using 0.1 N NaOH.

TABLE 1

Recovery of added formic acid from milk by the distillation procedure

Trial No.	Formic acid added	Formic acid recovered	
		Amount	Per cent
	mg./250 ml.	*mg./250 ml.*	
1 a	20.3	14.1	69.5
2 a	20.5	14.4	70.2
2 b	20.5	14.6	71.2
3 a	41.4	29.2	70.5
3 b	41.4	25.5	61.6
4 a	82.8	57.3	69.2
4 b	82.8	53.6	64.7
5 a	82.8	53.0	64.0
5 b	82.8	51.8	62.6
6 a	82.1	51.6	62.8
6 b	82.1	49.3	60.0
7 a	103.2	72.8	70.5
7 b	103.2	70.4	68.2
Avg.	.....	.....	66.5

RESULTS

Formic acid in unheated milk. Before subjecting heated milk directly to the formic acid procedure, trials were conducted with unheated (raw) milk. This was done to ascertain whether or not the heating of the milk during the formic acid determination would, in itself, create appreciable quantities of formic acid. Results revealed that, following correction for the reagent blank, formic acid results ranged from approximately 0.3 to 0.5 mg./250 ml. of milk, a negligible amount. Reagent blanks for the determinations were equivalent to less than 0.3 mg. of formic acid.

Recovery of added formic acid from milk. Since the previous study (3) had shown that complete recovery of formic acid was not obtained from an aqueous solution, it appeared desirable to ascertain the recovery of formic acid from milk. Results of such determinations are presented in table 1.

These data reveal that the distillation method recovered from approximately 60 to 70 per cent of the added formic acid with an average recovery of 66.5 per cent. In seven of the thirteen trials the recovery was more than 68 per cent, whereas in the other six trials the recovery was less than 65 per cent. Efforts to determine the cause for these variations were unsuccessful. One such effort involved the titration of the condensate to determine if appreciable quantities of acid were unremoved by the $BaCO_3$ trap. The results of these titrations did reveal that a slight and variable amount of excess acidity was found in the condensate. However, the amount in general was small and showed no relationship either with the quantity of formic acid in the sample or with the per cent recovery. Since, in later trials involving heated milk, the concentrate acidities were of the same magnitude, no correction is made to compensate for losses to this source.

TABLE 2

Formic acid produced by heating milk at 116° for one- and two-hour periods as determined by the distillation procedure

Heating period	Titrable acidity increase as formic	Formic acid measured	Corrected formic acid produced*	Proportion of total acid which is formic
	mg./100 ml.	*mg./100 ml.*	*mg./100 ml.*	%
One hour				
Lot 1	20.9	6.5	9.8	46.9
Lot 2	20.5	6.9	10.4	50.7
Lot 3	18.9	6.4	9.6	50.8
Avg.	20.1	6.6	9.9	49.2
Two hours				
Lot 1	38.6	13.6	20.4	52.8
Lot 2	35.8	14.4	21.6	60.3
Lot 3	40.3	15.6	23.4	58.1
Avg.	38.2	14.5	21.8	57.1

* Corrected on basis that only 66.5 per cent of formic acid in milk recovered by method used.

On the basis of the findings in table 1, it appears that the distillation method may be used at least fairly satisfactorily in determining the formic acid content of heated milk by assuming that recovery is only 66.5 per cent. This correction should give an accuracy within 5 per cent.

Formic acid in heated milk. Commercial homogenized, pasteurized milk was heated in the autoclave for one- and two-hour periods at 116° C. Titrable acidities were measured before and after heating and the increase in acidity expressed as formic acid. Formic acid determinations were made in 250-ml. quantities. Results are shown in table 2.

These data reveal that the formic acid actually recovered from the one-hour sample amounted to 32.8 per cent (6.6 mg./100 ml.) of the total titrable acidity, whereas the recovery was 37.9 per cent (14.5 mg./100 ml.) for the two-hour sample. By applying the correction, formic acid is found to consti-

tute, on the average, 49:2 and 57.1 per cent of the total heat-produced acidity for the one-hour and two-hour samples, respectively.

DISCUSSION

Results presented herein have several points in common with those in the earlier paper on this subject (3). The data again reveal the inadequacy of the distillation procedure to permit a direct, highly quantitative measurement of formic acid in milk. It is true that by use of a large corrective factor, results are obtained which appear satisfactory and which, for the time being, must be accepted as at least fairly accurate. However, a more sensitive and direct method of formic acid determination is desirable if a thorough study is to be made of the possible rôle of this acid in influencing the quality of dairy products processed at high temperatures.

The results in this study also again reveal the rather high concentration of formic acid produced by heat. However, the proportion of formic acid to total titrable acid in the milk itself is decidedly less than when the distillate was involved and when only volatile acids were concerned.

The difference between the titrable acidity results and the formic acid results may not represent only changes in heat-produced acid. As was pointed out earlier (4), various changes occur when milk is heated for such temperatures and times as used in this study, changes which may affect the titrable acidity although not necessarily involving acid production. It is interesting to note that the proportion of formic to titrable acidity increase is greater in the sample heated for two hours than in the sample heated for one hour, *viz.*, 49.2 per cent to 57.1 per cent. This may mean that as the heating time progresses there is (a) relatively greater production of formic acid than other acids, or (b) that there is less of these so-called "non-acid" changes. The previous work (4) does indicate that salt changes may occur early during the heating period and these changes may directly affect the titer.

SUMMARY

Formic acid determinations by the distillation method were made on milk to which known amounts of formic acid were added and on milk which had been heated for one- and two-hour periods at 116° C.

From 60 to 71 per cent of the added formic acid was recovered by the method used with an average recovery of 66.5 per cent.

Milk heated for one hour averaged 9.9 mg. of formic acid per 100 ml. of milk when the retention correction was used. This represented approximately 49 per cent of the total titrable acidity increase. In contrast, milk heated for two hours contained a corrected average of 21.8 mg. formic acid per 100 ml. of milk, or an amount equivalent to approximately 57 per cent of the total titrable acidity increase.

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LACTIC ACID IN DAIRY PRODUCTS. IV. EFFECT OF STORAGE OF EVAPORATED MILK ON LACTIC AND FORMIC ACID PRODUCTION, ON pH, AND ON ACIDITY AND FORMOL TITRATIONS[1]

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Preceding papers in this series (4, 8) have dealt with such factors as (a) microbiological changes and (b) high temperature heat treatment as they affect the lactic acid content of milk and milk products. One other important factor in this connection is that of storage, and it is the purpose of this paper to present information on this subject as it pertains to evaporated milk.

In connection with the lactic acid studies it appeared desirable also to ascertain the extent of other changes in evaporated milk which result from storage. Consequently, determinations were made on fresh and stored samples for formic acid, pH, titrable acidity, and formol titration.

PROCEDURE

Fresh evaporated milk was obtained directly from the manufacturers. Storage was at the specified temperatures with the samples being shaken at weekly intervals to prevent excessive fat separation and salt precipitation.

General methods of analysis were those used in previous studies (3, 4, 6, 7) with the exception that certain slight adaptations were necessary in order that the methods could be applied to the evaporated product.

The Hillig procedure (3, 9, 10) was used for lactic acid determinations. Some difficulty was experienced with the extraction of those samples stored for a considerable period of time at 120° F. due to the formation of a stable form which was carried over into the extraction flask. This difficulty was overcome by modifying the proportions of the precipitants used in preparing the serum for extraction, *i.e.*, using 9 ml. instead of 6 ml. of N sulfuric acid and 10 ml. instead of 5 ml. of 20 per cent phosphotungstic acid.

Formic acid was measured on a 250-ml. reconstituted sample (125 ml. evaporated milk and 125 ml. water) using essentially the A.O.A.C. method (1) described previously (5, 6). On the basis of earlier findings (6), correction of the results was made on the assumption that the method recovers only 66.5 per cent of the formic acid present.

pH determinations and titrations were made electrometrically, also on

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[1] Journal Article No. 772, new series, from the Michigan Agricultural Experiment Station.

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reconstituted samples. As in the previous study (7) titrations consisted of the following:

Normal—Untreated sample.

Oxalate—Sample treated with 2 ml. of a neutral saturated potassium oxalate solution per 50 ml. sample, prior to titration.

Formol—Addition of 5 ml. neutralized formalin per 50 ml. sample after titration, and again titrating to pH 8.3.

Formol oxalate—Formol titration of a sample treated with oxalate.

RESULTS

Effects of storage at different temperatures on lactic acid production. The first trials conducted in this study concerned the effect of storage period and temperature on the lactic acid content of evaporated milk. Samples of

TABLE 1

Effect of temperature and time of storage of evaporated milk on the lactic acid content

Temperature of storage (°F.)	Month of storage					
	0	1	2	3	5	7
	Lactic acid (mg./100 gm. evaporated milk)					
Series 1						
35	17.0	.....	16.0	17.0	16.6	18.6
70	.....	.....	18.6	18.6	18.6	18.4
100	.....	17.2	18.0	18.6	20.0	22.0
120	.....	17.2	30.0	30.0	34.0	..... *
Series 2						
35	10.0	.....	9.6	9.8	10.4	10.6
70	.....	.....	9.6	10.4	10.6	12.2
100	.....	10.4	11.5	11.6	11.6	12.2
120	.....	10.2	18.6	18.4	22.2	..... *

* Sample deteriorated to such an extent that analysis could not be made.

fresh evaporated milk, differing somewhat in lactic acid, were obtained through the courtesy of the Evaporated Milk Association from two different manufacturers. Samples were stored at 35°, 70°, 100°, and 120° F. with analyses being made at monthly intervals. Results are shown in table 1.

The results reveal that, in general, there is a tendency for the lactic acid content of the evaporated milk to increase in storage. However, increases at temperatures of 35°, 70°, and 100° F. for series 2, and at 35°, and 70° F. for series 1 are so slight as to be within experimental error. In both series, the storage at 120° F. produced appreciable quantities of lactic acid. However, these samples had deteriorated so greatly by the end of the second month that they were no longer of marketable quality.

Lactic and formic acid relationships. In additional trials, fresh samples of evaporated milk were again obtained from two different processing plants. These samples were stored at 100° F. for seven months. At monthly inter-

vals the following determinations were made: lactic acid, formic acid, pH, titrable acidity before and after oxalation, and formol titration before and after oxalation. Results for the lactic and formic acid determinations are shown in figure 1. Formic acid is expressed directly as measured by the A.O.A.C. method and also as corrected on the basis that recovery by the method is only 66.5 per cent. This is in accordance with earlier findings for milk (6).

This figure reveals again that storage at 100° F. for the length of this experiment produced negligible increases in lactic acid. The average lactic

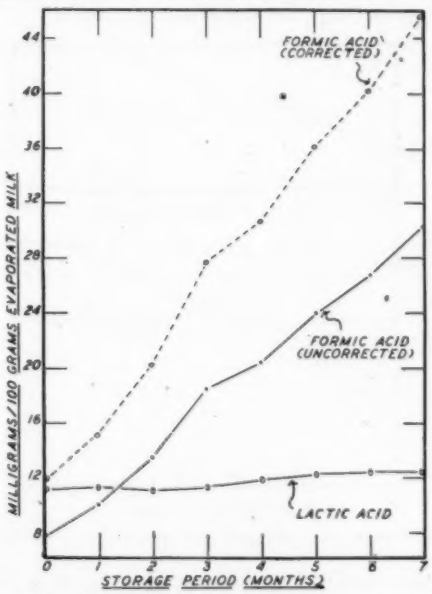

FIG. 1. Lactic and formic acid changes in evaporated milk stored for seven months at 100° F.

acid content of the samples was 11 mg. per 100 gm. and this value had changed to slightly over 12 mg. per 100 gm. by the end of the storage period.

The formic acid findings are in contrast to those for lactic acid in that they indicate a marked change during storage. The uncorrected formic acid results reveal an increase in formic acid from about 7.9 to 30.1 mg. per 100 gm. evaporated milk, whereas the corrected formic acid results show a change from about 11.9 to 44.8 mg. per 100 gm. evaporated milk.

Titrable acidity and pH. The effect of storing the evaporated milk on the acidity and formol titrations of normal and oxalated samples is shown in figure 2.

The results portrayed in this graph reveal that increases in titrable

acidity occur with storage, that the increase is greater when the measurement is on the oxalated sample, and that the formol titration undergoes no appreciable change.

The difference between the titration curves for the normal and for the oxalated samples is striking. Whereas the titers of the normal evaporated milk reveal a change during storage equivalent to about 8.7 ml. 0.1 N NaOH per 100 gm. milk, the titers of the oxalated sample show a change equivalent to 17.7 ml. 0.1 N NaOH per 100 gm. Furthermore, the titrable acidity curve levels off at about the fifth month of storage, but the oxalate curve continues upward throughout the entire storage period.

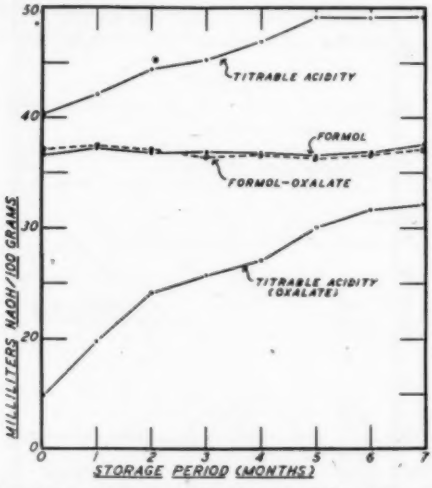

FIG. 2. Titration changes in evaporated milk stored for seven months at 100° F.

pH results on these samples are portrayed in figure 3. In general, these curves are in keeping with the titration results in figure 2. For example, the normal and oxalate curves exhibit a definite decrease in pH with prolongation of the storage period, the decrease being more marked in the case of the oxalated samples. However, the formol pH curves do not correlate completely with the respective titration curves. The pH curve for the formol titration of the normal sample indicate a slight but definite decrease, whereas the titration values themselves showed no distinguishable trend. Furthermore, although the pH curves for the formol-normal and formol-oxalate samples are at definitely different levels, the two respective titration curves were practically identical; *i.e.*, both samples required practically the same quantity of NaOH to adjust the pH to 8.3.

Titrable acidity and formic acid relationship. The fact that formic acid increases were so pronounced as a result of storage, raised the question as to

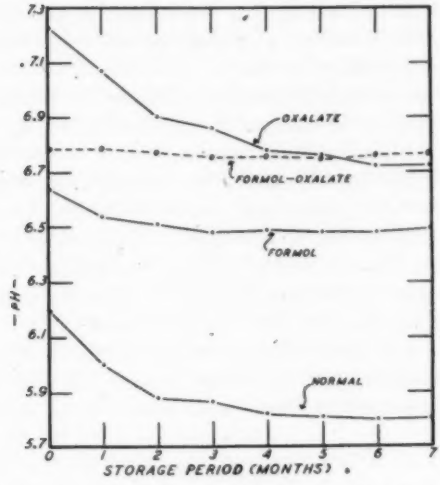

FIG. 3. pH changes in evaporated milk stored for seven months at 100° F.

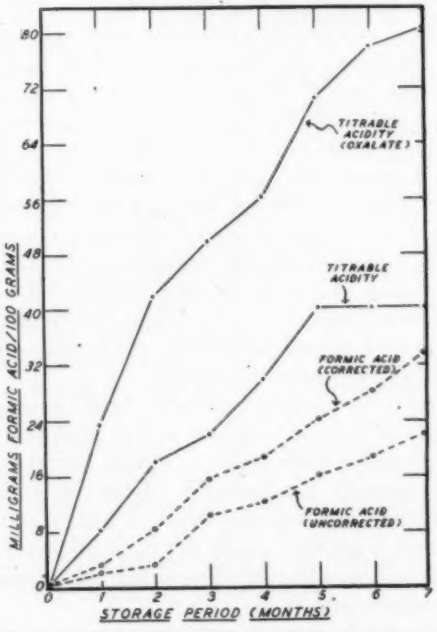

FIG. 4. Increases in acidity and formic acid in evaporated milk during seven months of storage at 100° F. (All values expressed as formic acid.)

the proportion of the titrable acidity which may be attributed to this acid. To throw light on the question, a comparison was made between the formic acid and the titrable acidity increases. The results of this comparison are shown in figure 4 in which all values are expressed as formic acid.

The curves representing changes in the titrable acidity and those representing increases in formic acid possess similar slopes for the first five months, but with the titrable acidity curve somewhat steeper. Following this period, however, the formic acid curves continued upward whereas the titrable acidity curve leveled off abruptly. At the close of the storage, the increase in formic acid amounted to 22.4 mg. per 100 gm. (uncorrected) and 33.8 mg. per 100 gm. (corrected) whereas the titrable acidity increase was equivalent to 40.4 mg. per 100 gm. evaporated milk.

A more drastic difference results when the formic acid to total acid comparison is made using the oxalate acidity values. In this case, the increase in acidity when expressed as formic acid was 80.6 mg. per 100 gm. evaporated milk.

DISCUSSION

The results obtained in this study reveal that formation of lactic acid in evaporated milk on storage is of no great significance. Even under extreme adverse conditions of storage, the amount of lactic acid formed would be so slight as to not invalidate any decision that might utilize the lactic acid content as being indicative of the quality of the original raw milk.

An interesting aspect of this study is the production of formic acid in the stored evaporated milk. In fact, it is interesting to note that even the fresh evaporated milk contains appreciable amounts of this acid, the amount averaging about 7.9 mg. per 100 gm. and 11.8 mg. per 100 gm. respectively on the uncorrected and corrected bases. However, the presence of formic acid in evaporated milk is not entirely unexpected since this acid is the result of sugar decomposition and since the heat treatment to which evaporated milk is subjected is sufficient to produce such decomposition. The marked increase in formic acid during the storage of the evaporated milk may be taken to indicate further lactose destruction.

In regard to these formic acid results, it should be emphasized that the method used is not entirely satisfactory and is doubtless lacking in sensitivity. The use of such a large factor to correct for retention in the distillation process is naturally not desirable. However, even with the shortcomings of this method, the results obtained definitely point the way to the fact that formic acid is present in milk products subjected to high temperatures and that this acid may be related to certain flavor changes and to color production in these products.

pH and titrable acidity changes which occur in evaporated milk on storage are to be expected on the basis of the formic acid findings; *i.e.*, the pH decreases and the titrable acidity increases. The decrease in pH from 6.2 to 5.8 is in accordance with the findings of Doan and Josephson (2). The

pH curve exhibited a definite leveling off after about the fourth month of storage and the titrable acidity ceased to increase after the fifth month.

The effect of the milk salts on titrable acidities is indicated by the results obtained. It is known that storage of evaporated milk results in the formation of salt crystals which precipitate from the milk. Such crystals, in small quantities, were observed in these samples. Possibly the abrupt leveling off of the titrable acidity curve after the five-month period is a result of salt rearrangements and precipitation, these changes compensating for the increase in acidity created by formic and other acids. The difference between the oxalate curve and the titrable acidity curve further emphasizes the salt effect. Since the oxalate curve exhibited a greater acidity change than the normal titration curve and, furthermore, since it revealed a steady acidity increase throughout storage whereas the normal titration curve did not, the possibility exists that the oxalate treatment of evaporated milk prior to titration may afford a superior means of measuring storage changes in acidity than is obtained by the standard titration.

Relative to the titration and pH results, it should be stressed that they need not apply precisely to all evaporated milk. In this study, these results are representative of storage changes in series of fresh evaporated milk obtained from two processors. However, differences in the quality of the original milk, differences in processing methods, or differences in the amount and kind of stabilizing salts may definitely influence the results obtained.

On the basis of the results obtained in this study, the formic acid produced in evaporated milk during the seven-month storage at 100° F. constitutes about 71.3 per cent of the total acidity as determined by titration when correction is made for retention in the distillation process. However, as indicated earlier in this discussion, to arrive at a strictly accurate value in this connection one is faced with two complications: (a) that the formic acid method used leaves considerable to be desired from the standpoint of extreme accuracy, and (b) that the titration procedure itself does not necessarily assure one of a true measure of total acid production. For example, one might prefer to use the formic acid values as obtained directly by the distillation procedure and without resorting to any further correction. In this case, the proportion of formic acid to total acid would be decidedly less, viz., 55.4 per cent as contrasted to 71.3 per cent. In addition, perhaps the acidity increase as obtained in the oxalate sample may be used to represent the true total acid change. Again, if such were done, the proportion of formic acid to total acid would be markedly less than if the standard titration results served as the basis of comparison. Additional studies on this subject are necessary before final conclusions may be drawn.

SUMMARY AND CONCLUSIONS

Increases in lactic acid in evaporated milk stored at 35°, 70° and 100° F. for seven months averaged 1.1, 1.7 and 2.4 mg. per 100 gm. respectively.

These small increases are, for all practical purposes, insignificant. However, storage of the milk at 120° F. for six months resulted in an average lactic acid increase of 14.6 mg. per 100 gms., but at this time the milk had deteriorated far beyond the marketable stage.

In an additional experiment in which evaporated milk was stored at 100° F. for seven months, lactic acid changes were again insignificant, but marked increases occurred in titrable acidity and formic acid, accompanied by a decrease in pH. Titrations of oxalated samples indicated much larger acidity increases than were revealed by the standard titration procedure. Formol titrations were essentially unaffected by storage.

Formic acid constitutes a significant portion of the total acid produced in evaporated milk as a result of storage. Under the conditions of this experiment, and when the recovery of formic acid is corrected for retention, the increase in formic acid during storage was equivalent to 71.3 per cent of the total acidity increase as determined by titration.

Limitations of the methods and possible applications of the findings are discussed.

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INFLUENCE OF HOMOGENIZATION OF FAT ON HAIRCOAT OF DAIRY CALVES

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Many reports have been made concerning the value of filled milks (skim milk and an unnatural fat) for rearing young calves. In studies on infant nutrition the importance of the size of the fat particles is often stressed but little actual evidence has been provided to support this theory. In most calf-feeding trials no attention has been given to the physical form of the fat. In one trial (1) the authors mention a characteristic loss of hair but do not associate it with the physical condition of the fat.

A year ago we started feeding skim milk and soybean oil (hereafter referred to as ration one) to calves on the fifth day after birth. Skim milk was warmed and fed with a nipple pail at the rate of 7.5 pounds daily per hundred pounds liveweight. The oil was given by syringe after the milk was fed. We had expected to give an amount of oil equivalent to 3.3 per cent of the skim milk but were forced to reduce the amount to approximately 2 per cent to avoid nutritional scours. Alfalfa hay and a grain mixture consisting of ground corn, rolled hulled oats, bran, and linseed meal were fed, *ad libitum*. The grain mixture contained 1 per cent salt, 1 per cent bone meal, and 0.05 per cent irradiated yeast. Each calf received a fish oil concentrate thrice weekly equivalent to 8500 I.U. of vitamin A per day.

By the time these calves were two weeks old the hair on the inside of the thighs began to fall out (see figure). In most cases only the hair over the perineal region was affected, although occasionally the hair about the muzzle also dropped out. A heavy "dandruff" developed over the rest of the body but the hair appeared fairly healthy. Scrapings from the perineal region which were examined by the Veterinary Pathology Department showed no primary infection or parasitic organisms, nor was the alopecia due to soiling of the hair with fecal material.

The first disturbance to be noted in the perineal region was a cracking of the skin. Within a few days the outer epidermal layers, together with the hair, would die and slough off. Although this condition produced some discomfort, the calves showed no marked tendency to rub or lick the affected area. The skin remained free of hair until the calves began eating hay or grain. Within a few weeks after their rumens started to function the hair began to grow again even though the oil was still fed in an unhomogenized

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form. Calves started on skim milk and oil after they had begun to ruminate never developed the condition just described. Other oils, including butter oil, had the same effect on the haircoat as soybean oil.

A second group of calves was fed on skim milk into which soybean oil was homogenized (hereafter referred to as ration two). Twice a day the desired amount of oil was homogenized into about a pint of warm separated skim milk with a hand homogenizer, then made up to the required volume and fed with a nipple pail. No calf in this group lost any hair prematurely.

A calf which previously had been fed on skim milk and soybean oil (ration one) was fed with this group on ration two. It was kept muzzled

FIG. 1. Effect of feeding unhomogenized oil on haircoat of young dairy calves.

so it could get no roughage or grain. After seven days on ration one the hair began falling out. When given ration two the hair again started to grow. Ration two was then replaced by ration one and within ten days the upper layers of the skin in the perineal region began cracking and showing a very definite metabolic disturbance.

We are unable to offer any explanation for the condition just described. It should be emphasized that the alopecia we have described has never occurred with calves fed unhomogenized fats if the calves were already eating hay and grain.

Calves reared on filled milk are usually slow to start eating any feed other than milk. A few analyses of the feces showed a higher per cent of fatty acids and neutral fat in the feces of calves fed the unhomogenized oil. The haircoat of calves fed the unhomogenized oil appeared to have a normal oil content as judged by luster and handling qualities while the

desquamated material from the denuded areas was always quite oily. Calves fed skim milk and either homogenized or unhomogenized oil grew at a rate below normal. Methods of at least patially overcoming this growth difficulty have been found and will be discussed in a later paper.

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THE EFFECT OF INCREASING THE NEGATIVE PRESSURE AND WIDENING OF THE VACUUM-RELEASE RATIO ON THE RATE OF REMOVAL OF MILK FROM THE UDDER[1, 2]

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According to Brodell and Cooper (1), six million hours per day or about 10 per cent of the total labor necessary for all farm operations are required to milk the cows in the United States. Dahlberg (3), Zehner (8), and Carter (2) have reported significant decreases in the time required for mechanical milking by the adoption of certain management procedures. Matthews, Shaw and Weaver (5), Foot (4), Matthews, Swett and Graves (6) and others have studied the rates of milking by machine, but no work has been reported on the effect of varying negative pressures and changes in pulsation ratios upon the speed of milk withdrawal.

EXPERIMENTAL METHODS

The relation of varying negative pressures and pulsation ratios to the rate of milk withdrawal was studied under three different plans. The first was to ascertain the amount of milk withdrawn in one minute at the height of milking by the use of a special apparatus. Two vacuum flasks were joined to the milking machine pail by a vacuum hose so that both had the same negative pressure. A standard teat cup was attached so that by the use of a Y-tube and forcep clamps the milk could be deflected into either flask. In the trials, milk was run into one flask until there was a full flow, then for exactly one minute the milk was shunted into the other flask and measurement made for the rate of flow per minute. Each of the four quarters was tested at 10.0, 12.5 and 15 inches Hg negative pressure and pulsation ratios of 1:1 and 3:1. The latter represents the relative time of vacuum application and release.

In the second plan the rates of milk withdrawal were ascertained for the entire udder with a standard milking machine for the first three minutes of milking. The milking pail was suspended from a scale and readings taken every 10 seconds. The rates for 1:1 and 3:1 pulsation ratios at 10, 12 and 14 inches Hg negative pressure were determined on three cows.

In the third plan, eight cows were milked by the same procedure followed in the second, except scale readings were taken to the "end point" of the milking. This point was arbitrarily established as the time when

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[1] Paper No. 2253, Scientific Journal Series, Minn. Agr. Expt. Station.

[2] The data in this paper are taken from a thesis presented by Vearl R. Smith in partial fulfillment of the requirements for the degree of Doctor of Philosophy, University of Minnesota.

three successive scale readings were 0.3 pound or less or when two successive readings were identical, whichever occurred first. Also the third plan differed from the second in that a 2:1 pulsation ratio was compared with 1:1. The 3:1 and 2:1 pulsation ratios used in these experiments were obtained in specially constructed pulsators in which the vacuum was on for three and two times as long respectively, as the release.

In all experiments the cows were stimulated to let down their milk by 15- to 20-second wash and massage of the teats and udder two minutes before the machine was attached. The machine was operated at 50 pulsations per minute. In all cases the cows were stripped by manipulation of the teat cup assembly and the total milk ascertained for each milking. Except for plan one, in which a specially constructed machine was used, a standard double action, floor type milking machine was used throughout these experiments.

Under the first two plans, six, and in the third plan, ten, observations were made on each pulsation ratio and negative pressure level combination. In order to avoid differences in milk production levels due to a lapse of time, each pulsation ratio and negative pressure level combination was observed for one day each in series and the series repeated 6, 6, and 10 times, respectively, for the three plans.

RESULTS

The results obtained in the study of the rates of milk withdrawal for one minute for each of the three levels of negative pressure are presented for each of the quarters in table 1. It is to be noted that for any level of negative pressure, there is significant variation in the rate of milk withdrawal for the different quarters. For each of the quarters there is a significant increase in the rate of milking for each of the increases in negative pressures.

TABLE 1

Mean milk flow for one minute from individual quarters at three levels of negative pressure

Expt. No.	Negative pressure	Quarters			
		R.F.	R.R.	L.R.	L.F.
	Inches Hg	*ml.*	*ml.*	*ml.*	*ml.*
I	10.0	245	265	395	250
II	12.5	380	388	483	438
III	15.0	518	548	635	518
	Per cent increase				
II over I		55.1	46.4	22.3	75.2
III over II		36.3	41.2	31.5	18.3
III over I		111.4	106.8	60.8	107.2

A much greater increase in milk flow is observed for the left front than for the left rear quarter, by increasing the negative pressure from 10.0 to 12.5 inches Hg, the increase being 188 and 88 ml., respectively. A smaller increase in milk flow from the left rear than the left front resulted when the negative pressure was increased from 12.5 to 15 in. Hg. The values were 80 ml. and 152 ml., respectively.

The percentage increase in milk withdrawal rates for each increment in negative pressures are also given in table 1. For three quarters the rates were more than doubled by increasing the negative pressure from 10 to 15 inches Hg, while for one, the left rear quarter, the increase amounted to only 60.8 per cent.

TABLE 2

Mean rates of milk withdrawal in pounds per ten seconds for 3 cows with 1:1 and 3:1 pulsator ratios at 10, 12, and 14 inches Hg negative pressures. Observations were made over three minute periods

	Inches Hg negative pressure						Average amount milk per milking
	10		12		14		
	Pulsator ratios						
	1:1	3:1	1:1	3:1	1:1	3:1	
							lbs.
Cow E390	0.65	0.74	0.72	0.85	0.80	0.89	16.8
E401	0.50	0.61	0.64	0.78	0.71	0.82	17.3
E405	0.52	0.58	0.64	0.69	0.74	0.84	17.7
Average	0.56	0.64	0.67	0.77	0.73	0.85	—
Ave. per cent increase from 1:1 ratio and 10 in. Hg							
	—	14.2	19.6	37.5	30.4	51.8	—
Ave. per cent of total milk in 3 minutes							
	56.9	68.7	69.3	80.7	78.0	87.4	—

In table 2 is presented the summary of the results for three cows on which observations were made for a three-minute period with 1:1 and 3:1 pulsation ratios at 10, 12 and 14 inches of Hg negative pressure. Observations on 16 inches Hg negative pressure were discontinued because of the pain to the cow and congesting effect this level had on the teats with the 3:1 pulsation ratios. These effects were also quite noticeable for the 14-inch Hg level, and progressively less for the 12 and 10 inches Hg negative pressure, respectively.

It is to be noted that the rate of milk withdrawal increased progressively with each increment in the negative pressure used for both the 1:1 and 3:1 pulsation ratios. The 3:1 ratio pulsations milked faster than the 1:1 ratio by 14.2, 14.9 and 16.4 per cent, respectively, for 10, 12 and 14 inches negative pressures. The increases for the rates of milk withdrawal in per cent of milk obtained with the 1:1 at 10 inches of Hg negative pressure were

TABLE 3

Mean rates of milk withdrawal in pounds per 10 seconds up to "end point" for 8 cows with 1:1 and 2:1 pulsator ratios at 10, 12, 14 and 16 inches Hg negative pressures

	Inches Hg negative pressure								Ave. amt. milk per milking
	10		12		14		16		
	Pulsator ratios								
	1:1	2:1	1:1	2:1	1:1	2:1	1:1	2:1	
									lbs.
Cow A12	0.44	0.51	0.52	0.59	0.62	0.63	0.69	0.71	17.6
A30	0.51	0.58	0.64	0.72	0.72	0.84	0.74	0.89	16.3
A55	0.42	0.44	0.48	0.51	0.53	0.59	0.65	0.63	15.0
E401	0.42	0.46	0.55	0.59	0.62	0.70	0.71	0.77	13.0
E405	0.42	0.49	0.55	0.60	0.62	0.70	0.65	0.69	12.4
E408	0.49	0.56	0.61	0.62	0.65	0.70	0.69	0.70	13.9
E413	0.51	0.54	0.58	0.58	0.66	0.71	0.74	0.72	14.8
305	0.56	0.65	0.65	0.73	0.71	0.79	0.77	0.79	12.2
Average	0.47	0.54	0.57	0.62	0.64	0.71	0.71	0.74	.....
Ave. % increase from 1:1 ratio 10 ins. Hg	.....	14.9	21.3	31.9	36.1	51.1	51.1	57.4	.....

19.6 and 30.4 for the 1:1 ratio pulsator, and 37.5 and 51.8 for the 3:1 ratio pulsator, respectively, for 12 and 14 inches Hg negative pressure. The rate of milking by the 3:1 ratio pulsation corresponded, roughly, to the rate obtained with the 1:1 ratio pulsation at a negative pressure 2 inches of Hg higher.

The mean rates of milk withdrawal up to the "end point" for 1:1 and 2:1 pulsation ratios at 10, 12, 14, and 16 inches Hg negative pressure levels are presented in table 3. These values are lower than in the previous experiment because they include a tapering off in milk flow rate as the "end point" is reached, as is shown in figure 1. The values, however, are more nearly what would be expected in practice, as stripping should begin at the "end point."

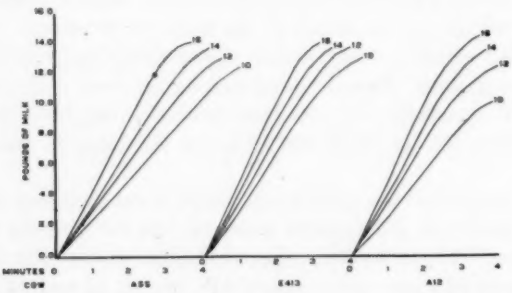

FIG. 1. Graphic presentation of rates of milking to the "end point" at 10, 12, 14 and 16 inches Hg negative pressures for 3 cows.

As in the previous experiment, increases in rates are observed for each increment in the negative pressure level. The 2:1 ratio pulsation withdraws milk more rapidly than the 1:1 ratio pulsation. The rate of milking by the former corresponds roughly to 2 inches higher negative pressure in the 2:1 ratio pulsation. Considerable variation is to be noted in the rate of increased milk flow by different cows at different negative pressure levels.

The time required in minutes and seconds to reach the "end point" with the two pulsation ratios and various negative pressure levels is presented in table 4 for the eight cows studied. There is considerable individual variation in the shortening of time at which the "end point" is reached as affected by the wider pulsation ratio and increments in the negative pressure levels. On the average, each two inches Hg increase in the negative pressure, over the ranges studied, caused a shortening of this period by 25 seconds. For

TABLE 4

The time in minutes and seconds when the "end point" was reached in milking 8 cows with 1:1 and 2:1 pulsator ratios at 10, 12, 14 and 16 inches Hg negative pressure

	Inches Hg negative pressure							
	10		12		14		16	
	Pulsator ratios							
	1:1	2:1	1:1	2:1	1:1	2:1	1:1	2:1
Cow A12	3:50	3:40	4:00	3:50	3:40	3:40	3:30	3:20
A30	5:00	4:30	4:10	3:40	3:30	3:10	3:10	2:50
A55	5:00	4:40	4:30	4:10	4:10	3:50	3:40	3:40
E401	4:20	4:20	3:50	3:30	3:20	3:00	2:50	2:30
E405	4:10	3:50	3:40	3:10	3:10	2:50	2:40	2:40
E408	3:40	3:20	3:20	3:10	3:00	2:50	2:50	2:40
E413	4:20	4:10	4:00	3:50	3:30	3:10	3:10	3:10
805	3:00	2:40	2:20	2:00	2:00	1:50	1:50	1:40
Average	4:10	3:54	3:44	3:25	3:18	3:03	2:55	2:36

any negative pressure level the 2:1 pulsation ratio, on an average, reduced the time to reach the end point approximately 15 seconds as compared with the 1:1 pulsation ratio. The 2:1 pulsator ratio with 16 inches Hg negative pressure averaged 2 minutes, 36 seconds to reach the "end point," while 4 minutes, 10 seconds was required by the 1:1 pulsation at 10 inches Hg negative pressure, or a difference of one minute 34 seconds.

In table 5 is presented a summary of the per cent of the total milk that was obtained when the "end point" was reached over the range of these studies. Again there is considerable individual variation. On the average, there is a progressive and significant increase in the per cent of the total milk obtained by the 2:1 pulsation ratio at 10 inches Hg negative pressure level and for both pulsation ratios with each increment in negative pressure level up to and including 14 inches Hg. On the average, a smaller percentage of the total milk was obtained for both pulsation ratios at the 16-inch Hg level of negative pressure. At this level an equal or larger proportion

of the milk was obtained for five cows by the 1:1 pulsation ratio, and less for the 2:1 pulsation ratio for all but one cow. In one case (805) there was a progressive decrease in the completeness of milking at the "end point" for each increment in the negative pressure.

TABLE 5

The per cent of the total milking obtained when the "end point" was reached in milking 8 cows with 1:1 and 2:1 pulsator ratios at 10, 12, 14 and 16 inches Hg negative pressures

	Inches Hg negative pressure							
	10		12		14		16	
	Pulsator ratios							
	1:1	2:1	1:1	2:1	1:1	2:1	1:1	2:1
Cow A12	57.8	65.0	72.2	77.8	76.3	80.2	72.2	79.9
A30	94.2	94.3	96.7	96.4	94.2	96.7	96.2	94.2
A55	82.6	82.4	87.5	87.5	91.4	90.6	93.5	91.8
E401	86.5	91.7	93.7	93.8	95.1	95.7	95.1	94.4
E405	87.8	91.5	92.5	92.2	91.9	93.8	89.7	91.9
E408	88.4	88.6	92.4	92.9	89.2	91.6	90.8	90.1
E413	88.9	93.1	92.9	92.4	91.7	92.6	93.5	92.4
805	81.8	83.0	78.3	77.4	70.9	70.2	65.8	63.7
Average	82.8	85.7	88.1	88.8	88.6	89.0	87.8	87.3

DISCUSSION OF RESULTS

While withdrawing milk for exactly one minute at the height of milking is an acceptable method to determine the effect of changes in the factors studied upon the maximum rates of milk withdrawal, it does not permit of an overall evaluation in practice. As subsequent experiments have shown, the completeness of milking is also affected by the factors studied. After preliminary trials the "end point" as herein used was chosen because at that point stripping should begin. The "end point" does not necessarily represent the extent to which the udder has been evacuated but rather a decline in the rate of flow of milk to a point where possible injury may result from the entrance of the negative force into the teat sinus.

In the cases where considerable milk was left in the glands when the "end point" was reached the decline in rate of milk withdrawal was caused by the upward crawling of the teat cups to partly or completely occlude one or more of the orifices between the teat and gland sinuses. Restoration of the maximum rate of milk withdrawal when the teat cups were pulled downward is proof of that fact. The tapering off in the rate of milk withdrawal toward the approach of the "end point," as shown in figure 1, may, in addition to the upward crawling of the teat cups, be due in part to a number of factors. Lowering of the intraglandular pressure due to the withdrawal of milk no doubt is an important contributing factor. Obstructions in the passageways for the milk and of course the more complete milking out of quarters producing less milk must also be considered.

While every increase in negative pressure resulted in an increased rate of milk withdrawal the rate of increase varied for different levels and for different cows. These variations can be explained on the basis that the negative force affects speed of milk removal in two ways. One is the effect upon the opening of the teat meatus, and the other is upon the rate of flow through the meatus. With every increase in negative pressure there is a proportional increase in the rate of flow through the meatus. To test out this point, skim milk was drawn through a hypodermic needle inserted through a rubber stopper at 10, 12, 14 and 16 inches negative pressure and rates of flow determined over a five-minute period. When the results for 14 trials at each level of negative pressure were plotted, a straight line increase with increased negative forces was observed.

The difference in the opening of the meatus therefore can account for great variation in the rates of increase in milk flow with increased negative pressure, both within and between cows. It seems obvious that the amount of force to open the meatus, maximally, will depend upon the tension of the sphincter muscles surrounding it. Other factors, such as stenosis of the passageways for the milk, either in the teat or gland sinuses or in the ducts of the gland, are often contributing causes for restriction of milk flow. Fibrotic growths, often present in the teat sinus, contribute greatly to an early occlusion of the passageway for milk in the milking process.

The notable shortening of the time to reach the "end point" with each increment of negative force is not the only criterion in speed of milking. In several cases a part of the time saved by reaching an earlier "end point" is offset by more time being required for removing larger amounts of milk as strippings. Why there should be, as an average, more complete milking at the "end point" with each increment of negative pressure up to and including 14 inches Hg is difficult to explain. The less complete milking with the higher negative pressure can be explained by a tendency for the teat cups to crawl upward earlier to partially or completely obstruct the passageways for the milk. The shape of the udder is a factor in the completeness of milking when the "end point" is reached. Cow 805 had funnel-shaped quarters, which offer less resistance to the crawling tendency than teats on udders with level floors. In her case, not only was the milking less complete at the low negative pressure level but progressively more milk was left in the udder when the "end point" was reached with each increment of the negative force.

As milk flows only when the inflation is distended, which in the normal pulsator is approximately one-half of the pulsation cycle, it would be expected that when the "vacuum" to release ratio is widened that milking rates would be increased. With both the 3:1 and 2:1 pulsation ratios rates of milking were increased but not proportional to the increased time over which the inflation is distended. Theoretically the 3:1 pulsation ratio

should increase the rate of milk withdrawal 50 per cent and the 2:1 ratio 33.3 per cent over the 1:1 pulsation ratios. The observed increases were 17.6, 16.0 and 8.8 per cent respectively for 10-, 12-, and 14-inch Hg levels for the 3:1 ratio and 12.2, 7.9, 10.5 and 4.6 per cent respectively for 10-, 12-, 14-, and 16-inch Hg levels for the 2:1 ratio pulsations. The reasons for this discrepancy between the observed and the theoretical values are obscure. The tendency for a lesser increase in rates of withdrawal for wider pulsation ratios at the higher negative pressure levels can be explained by postulating that the level of maximum drainage rates from the gland is being reached.

While faster milking is desirable and from these studies can be accomplished by either widening the pulsation ratios or increasing the negative pressures or a combination of both there is obviously a practical limit beyond which one should not go. It was not the purpose of these studies to ascertain such a limit but attention must be directed to the fact that as the milking force is increased a greater traumatizing action is exerted upon the inside of the teat after milk ceases to flow out of the meatus as has been shown by one of us (7). Widening the pulsation ratios also has a tendency to increase the congestion in the teat. This latter condition could no doubt be largely overcome by increasing the pulsation rate so as to reduce the time the vacuum is applied to the teat with each pulsation.

SUMMARY AND CONCLUSIONS

1. Data involving observations on 12 cows are presented to show the effects of increasing the negative pressures and widening the pulsation ratios upon the rates of milk flow and the completeness of milking.

2. Rates of milk withdrawal at the height of milking were established for 1 minute at 10, 12.5 and 15 inches Hg negative pressures and rates per 10 seconds for the 1:1 and 3:1 pulsation ratios at 10, 12 and 14 inches Hg and for the 1:1 and 2:1 pulsation ratios at 10, 12, 14 and 16 inches Hg negative pressure levels.

3. Each increment in negative pressure in the range of 10 to 16 inches Hg, increased the rate of milk withdrawal but not at uniform rates for all cows.

4. Widening the pulsation ratio increased the rate of milk withdrawal but not in proportion to the increased time of vacuum application.

5. In general there was lesser increase in the rate of milk withdrawal by the wider pulsation ratios as the negative pressures increased.

6. The effect of negative pressure and widening of the pulsation ratios upon the completeness of milking was variable. In the lower ranges increased negative pressure affected a more complete average evacuation of the gland at the "end point." At 16 inches Hg negative pressure the reverse maintained.

7. Shape of the udder contributes to completeness of milking. Funnel-shaped quarters milk out less completely than those where the udder floor is level.

ACKNOWLEDGMENT

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THE KEEPING QUALITY OF SAMPLES OF COMMERCIALLY DRIED MILK PACKED IN AIR AND IN INERT GAS*

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The primary cause for the spoilage of dried milk is the autoxidation of the fat. The rate of autoxidation varies with the quality of the milk; the moisture, copper, and iron content; the method of processing; the temperature of storage; and the oxygen content of the atmosphere of the container.

With the advent of the war a special need arose for dried milk that would remain in good condition for at least six months to one year under severe conditions of handling and storage. At that time some of the dried milks were packaged in air and some in inert gas or gases.

Among the questions which confronted the potential users of large quantities of the product as well as manufacturers, were (a) what is the general keeping quality of commercial dried milk at different temperatures of storage; (b) how can the keeping quality of dried milks be predicted; and (c) to what extent can the keeping quality be augmented by packing the product in an inert gas? The work described herein was designed to answer these questions.

EXPERIMENTAL

Six lots of dried milk, approximately 1500 1-pound samples, were obtained from various manufacturers. One-half of each lot of samples had been packaged in inert gas or gases according to the practice of the manufacturer. The other half of the samples had been packaged in air.

Air- and gas-packed samples were stored at each of the following temperatures: 20°, 30°, 37°, 45°, and 55° C. (68°, 86°, 98.6°, 113°, 131° F., respectively). At regular time-intervals a container was removed from each set of samples stored at each of the temperatures, the contents were judged for off-flavors and odors, and the peroxide value was determined on the fat of each sample.

The determination of the oxygen content of the gas-packed samples was not made immediately but was made at a later date on several samples of each lot.

The samples were reconstituted and stored for off-flavors and odors by three judges. The peroxide value was determined as follows:

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The fat was extracted from 240 g. of dried milk with 560 ml. of hot carbon tetrachloride by agitating the mixture vigorously with a motor-driven stirrer for 10 minutes (Fig. 1). The mixture was poured on a folded filter and the residue washed four times with 15 ml. of hot carbon tetrachloride. The combined filtrate and washing were evaporated in an all-glass apparatus under vacuum until all the solvent had been removed.

FIG. 1. High-speed agitator with irregular shaped container.

Approximately 1 gram of the extracted fat was weighed accurately into a glass vial. The vial and contents were transferred to a 300-ml. Erlenmeyer flask and the sides of the flask were washed down with 25 ml. of a mixture composed of two parts glacial acetic acid and one part chloroform by volume. One milliliter of a saturated aqueous solution of KI was added and the mixture was rotated gently and placed in the dark for exactly 3 minutes. The contents of the flask were then diluted with 100 ml. of distilled water and 5 g. of sodium acetate was added. The flask was rotated to dissolve the sodium acetate and the liberated iodine was titrated with 0.002 normal sodium thiosulfate, a starch solution being used as an indicator. The number of milliliters of thiosulfate required to titrate the iodine liberated by 1 gram of fat is the peroxide value.

AIR-PACKED SAMPLES

Peroxide values. At relatively low storage temperatures the rate of formation of peroxides in milk fat is slow but exceeds greatly the rate of their destruction. As a result, the amount of peroxides usually increases logarithmically with respect to time. Any deviation from such a progressive rate of increase usually indicates an increase in the rate of decomposition of peroxides. This breakdown of peroxides occurs readily at the higher temperatures, but occurs also at relatively low temperatures if the time period of storage is relatively long, and results in tallowy off-flavors and odors.

Since the periods of storage in this investigation were usually relatively long, it was expected that excessive decomposition of peroxides might occur

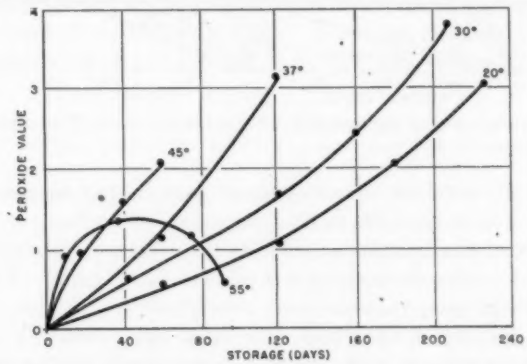

FIG. 2. The increase of peroxide value in the fat of a dried milk held at different temperatures.

at the higher storage temperatures and would therefore make it impossible to follow accurately the rate of oxidation by means of the increase in the peroxide value.

The rate of peroxide formation in the fat in a representative sample of dried milk stored at the various temperatures is shown in figure 2.

The rates of peroxide formation at 20°, 30°, and 37° C. follow logarithmic courses and there is no indication of any considerable decomposition of the peroxide formed. However, at temperatuers of 45° and 55° the rates of autoxidation as determined by the peroxides present are not logarithmic, and indicate a progressive increase in the rate of decomposition of peroxides as the storage temperature increases.

Figure 3 shows the rates of accumulation of peroxides in the samples of the six lots of dried milk used, at storage temperatures of 20°, 30°, 37°, and 45° C. The relative keeping quality is indicated by the rates of peroxide formation.

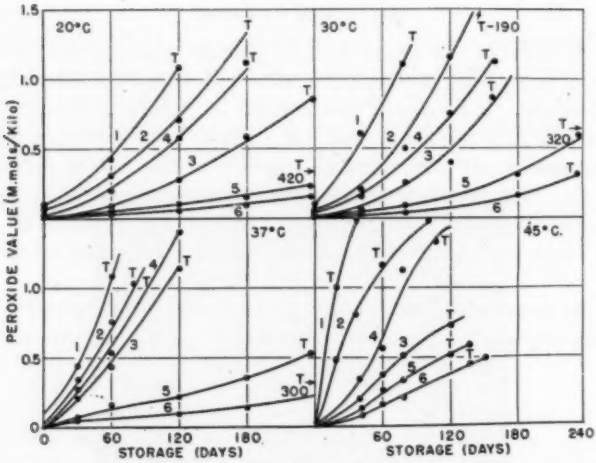

FIG. 3. The increase of the peroxide value in the fat of six dried milks held at different temperatures.

Although the peroxide values obtained were subject to some variations because of the small amounts to be determined, the values may be used to obtain the rate of autoxidation at different temperatures, provided, however, that the peroxide value chosen as an end point is not too great. The peroxides are more stable at lower than at higher concentrations. Figure 4 shows the time in days required for the fat in the dried milks Nos. 1, 2, 3, and 4 to attain a peroxide value of 1.00, plotted logarithmically against the tempera-

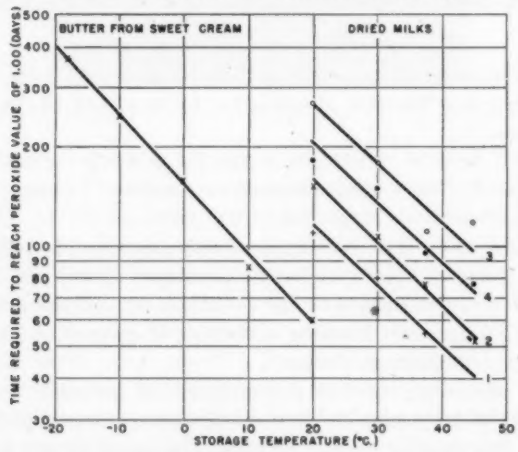

FIG. 4. The time required for the development of a peroxide value of 1.0 in dried milks and sweet cream butter.

tures of storage. Values for sweet-cream butter (1) stored at −17° to 20° C. are also given in figure 4.

The values for dried milks Nos. 5 and 6 were not included, since in neither of these did the peroxide value of the fat reach a value of 1.00 before they were judged tallowy. Although some of the values do not conform well to the curves, the differences in the rates of oxidations as related to the differences in the storage temperatures seem to be in each case approximately the same as for those of sweet-cream butter. For each decrease of 10° C. in the storage temperature, the number of days of storage required to effect the same degree of autoxidation increases approximately 1.6 times.

Off-flavors and odors. The rate of peroxide formation was of value in determining the relative rates of autoxidation of fats and can be used as an index of the comparative keeping qualities of dried milks packed in air, if the storage temperature is not above 45° C. However, the amount of peroxides formed may not be the same in all cases in which sufficient amounts of

TABLE 1

Comparison of the keeping quality of six lots of dried milk, based on the flavor and on the peroxide value at the end of the second sampling period

Time of storage	Temperature	Increasing off flavor →						Increasing peroxide value →					
days	*°C.*	*lot number*						*lot number*					
30	55	6	5	4	3	2	1	6	5	3	4	2	1
40	45	6	5	4	2	3	1	6	5	3	4	2	1
60	37	6	5	4	3	2	1	6	5	3	4	2	1
80	30	6	5	4	2	3	1	6	5	3	4	2	1
120	20	6	5	4	3	2	1	6	5	3	4	2	1

peroxides have been decomposed to produce tallowy flavors. This is illustrated in figure 3, in which the time when the milks were first judged tallowy (T) is indicated on the curves for the rate of peroxide formation.

In general, tallowiness occurs at a lower peroxide value when the periods of storage are long. There is also some evidence in these results that peroxides decompose more readily in some dried milks than in others. This fact may lead to inconsistencies in the comparative results obtained by the organoleptic test and the peroxide value methods of judging keeping quality. The rates of peroxide formation in the fat can be used as a fairly reliable test of the relative keeping quality of dried milks. This is shown also in table 1 in which is given the order of increasing off-flavor and peroxide value of six lots of dried milk at the second sampling period.

INERT GAS PACKING

As indicated previously, one-half of each lot of samples had been packed in inert gas by the manufacturers. These samples were stored at the same temperatures as the air-packed samples and their peroxide values determined and flavors and odors judged at the same intervals.

Of the gas-packed samples four lots had oxygen concentrations of approximately 3 to 4 per cent, the percentage differing somewhat between containers.

Peroxide formation. The rate of formation of peroxides in these samples was low and in most cases did not reach a value which could be considered significant. In many cases the peroxide value reached a maximum of approximately 0.50 and remained at this value for a long time. Often samples were judged tallowy when there had been little change in the peroxide value over a long period of storage. This can be accounted for only by the assumption that the rates of formation and destruction of peroxides were almost equal and that eventually enough oxygen was absorbed and its initial reaction product destroyed to render the product tallowy.

TABLE 2

The time of storage at 37° C. necessary to produce a tallowy odor and flavor in dried milk samples packed in air and inert gas

Sample	O_2 content	Time of storage
	%	*days*
1. Air	.....	60
Inert gas	3.86	150
2. Air	.....	60
Inert gas	4.69	210
3. Air	.....	120
Inert gas	3.38	240
4. Air	.....	120
Inert gas	3.94	270

It is evident therefore that the rate of peroxide formation in the fat of the gas-packed samples cannot be used as a measure of the relative keeping quality of the dried milks.

The number of days of storage at 37° C. required to develop the first definitely tallowy flavor in the air- and gas-packed samples of each of the four lots is given in table 2.

These values indicate that the keeping quality of the dried milks packed in inert gas of 3 to 4 per cent oxygen concentration was from two to three times that of samples of the same product packed in air.

Although the oxygen concentration of the gas in the containers of each lot was not the same, the results indicate that dried milks of relatively low keeping quality are benefited to a greater extent by packing in gas than are those of a better keeping quality.

The other two lots of gas-packed samples (Nos. 5 and 6) differed greatly in oxygen content. Consistent data were not obtained upon their keeping quality.

DISCUSSION AND CONCLUSION

The samples used in this work were obtained and studied in 1942. The

results indicate clearly that there was a great variation at that time in the keeping quality of commercially prepared dried milks. In most cases they were of such quality that those packed in air could not be relied upon consistently to withstand severe conditions of storage for 6 months to 1 year without developing oxidized flavors and odors.[1] However, those packed in an inert gas of an oxygen content of approximately 3 to 4 per cent had a much better keeping quality than those packed in air.

The tests of samples packed in air and stored at 20°, 30°, 37°, 45°, and 55° C. indicate that the rate of peroxide development at the temperatures up to 45° can be relied upon as a fairly accurate measure of the rate of autoxidation and as a measure of the relative keeping quality of dried milks, provided the criterion used is a relatively low peroxide value. The rate of peroxide development was not, however, necessarily an index of the time of storage necessary to develop tallowy odors and flavors in a gas-packed sample.

In general those samples which had an initial peroxide value of zero were of superior keeping quality.

Slight off-flavors and odors could usually be detected when the peroxide value reached approximately 0.50. When the keeping quality is determined by using the first off-flavor in the organoleptic test and a low peroxide value as criteria, the two tests agree reasonably well. The two tests do not agree as well when the criterion in the organoleptic test is too pronounced a flavor or when the criterion in the peroxide value test is too high. Therefore the peroxide value may be used as an index of the probable storage quality.

By the use of relatively high storage temperatures the keeping quality test can be greatly accelerated, since the rate of oxidation of the fat in a milk of good quality increases by a factor of approximately 1.6 × for each increase of 10° C. in the storage temperature.

Temperatures of 37° and 45° C. seem to be satisfactory to use in accelerated storage tests. A temperature of 55° was found unsatisfactory because of the destruction of peroxides and the development of discoloration and off-flavors not connected with fat oxidation.

Although the peroxide value may be used to determine the relative keeping quality of dried milks packed in air, the keeping quality of dried milks packed in an inert gas can best be determined by organoleptic tests made during storage to determine the onset of off-flavor and odor.

REFERENCE

(1) Holm, G. E., Wright, P. A., White, Wm., and Deysher, E. F. Jour. Dairy Sci., 21: 385–398. 1938.

[1] Great advances have been made in the manufacturing and packaging of dried milk in the past two years and the quality of the dried milks now manufactured is generally better than was the quality of some of those used in this work.

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The Constitution and By-laws of the American Dairy Science Association provides for the publication of the names of the nominating committee in the January issue of the JOURNAL OF DAIRY SCIENCE. It is the duty of this Committee of which **G. M. Trout** is the present chairman to send its report to the secretary not later than April 1. The secretary will then send out the ballots to secure a final vote before the annual meeting. The results of the election will be announced at the annual meeting.

As a member of the Association, it is your obligation to express your wishes for officers and directors to any member of this Committee. Two candidates for vice-president and four for directors will be nominated. The present vice-president automatically becomes president.

The Nominating Committee will give consideration to the wishes of the members as expressed by correspondence and also will consider additional candidates. They have been instructed to study the list of past officers and directors (see pages 803 and 804 of the August, 1943, Journal) to plan to secure good geographic distribution and to recognize the desirability of representation from all lines of activity of our members.

This change in the Constitution was made so that our Association could elect its officers in a democratic way. This can only be done, however, if our members are prompt in giving their opinions freely to the Nominating Committee.

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ABSTRACTS OF LITERATURE

BOOK REVIEWS

1. **Bioenergetics and Growth.** SAMUEL BRODY, Univ. of Missouri. 1023 pages. Illustrated. Reinhold Publishing Co., 330 W. 42nd St., New York. Price, $8.50.

In this book Dr. Samuel Brody in his characteristic thorough manner has integrated the results obtained from the researches sponsored by the Herman Frasch Foundation for Research in Agricultural Chemistry at the Missouri Agricultural Experiment Station. The work deals largely with the energetic efficiencies of animal production processes such as the production of milk, meat, eggs and work.

Space does not permit an adequate review of the contents which range over a wide field and include analytical appraisals of many livestock production processes. The literature is generously used and a page by page bibliography provided. A wealth of graphic and tabular data accompanies each chapter.

The book will be a most useful addition to the library of the research worker in the animal science field. The fact that it deals largely with specifics rather than broad generalities makes it particularly useful to the investigator. T.S.S.

2. **Dairy Bacteriology and Public Health.** C. S. BRYAN. Burgess Publishing Company, 426 S. Sixth Street, Minneapolis 15, Minn. 1945. 33 pp. $1.00.

This publication is useful as a handbook for veterinarians, milk sanitarians and teachers of microbiology as related to the dairy industry and its public health aspects.

The subject matter is divided into 12 divisions and is presented in outline form. It is assumed that teachers, students and sanitarians would have to rely upon other sources for complete information on detailed bacteriological and chemical techniques.

The material is presented in logical sequence, starting with the composition of milk and commercial milk products, grades of milk, sources and prevention of high bacterial counts in milk on the farm and in the processing plant. This is followed by the use and evaluation of different bacteriological quality tests. Essential steps are also listed for the examination and handling of water supplies to determine its potability. Dairy cleaners and cleaning of dairy equipment are discussed, emphasizing their effectiveness as sanitization agents and cleansing ability. The essential properties of cleaners are listed, such as wetting, emulsification, deflocculation, dissolving

power, buffer action and water-softening ability. The final discussion deals with a suggested procedure for inspection of milk on the farm and in the plant. H.H.W.

BUTTER

3. Vitamin A Potency of Idaho Butter. D. R. Theophilus, Olof E. Stamberg, D. W. Bolin, and H. C. Hansen. Idaho Agr. Expt. Sta. Cir. 102. 1945.

Samples of butter manufactured in Idaho were collected semimonthly from four areas for one year. The vitamin A and carotene contents were determined by chemical procedures and the sum of the two was the vitamin A potency.

It was found that the vitamin A potency was lowest, about 12,500 I.U., in February and March, and it was highest, about 19,000 I.U., in July to October. The decrease in carotene in the winter months was greater than the decrease in vitamin A. In July the vitamin A content of the butter was 1.3 times that of March butter and the carotene content in July was 2.2 times greater than March butter. If a uniformly high level of vitamin A potency is to be maintained, it would be necessary to improve winter feeding. A.C.D.

CHEESE

4. Studies on the Riboflavin Content of Cheese. I. L. Hathaway and H. P. Davis. Univ. of Nebr. Agr. Expt. Sta. Res. Bul. 137. 1945.

The riboflavin content of 27 kinds of cheeses and cheese spreads were determined by the rat assay technique. Most of the cheeses were purchased on the local market and a few were manufactured in the Nebraska Experiment Station creamery.

It was found that most of the cheeses contained from 3 to 6 micrograms of riboflavin per gram of cheese. Only cream cheese contained smaller amounts of this vitamin. Larger amounts were present in goat cheese, Mel-O-Pure, Leiderkranz, and Velveeta. Since duplicate cheeses were obtained for only two varieties, the results may not necessarily indicate differences between varieties. There appeared to be no significant difference in riboflavin content on the basis of classification of the cheeses as hard, semi-hard, soft, and process. A.C.D.

5. Matting of Cottage Cheese. Thos. B. Harrison and W. M. Roberts, Agr. Expt. Sta., Univ. of Tenn., Knoxville. Southern Dairy Products Jour., *38*, 3: 54. September, 1945.

When cottage cheese curd mats and becomes tough and rubbery, it can-

not be marketed. The Dairy Department of the University of Tennessee has made a preliminary study of the following possible factors: degree of acidity, amount of rennin, addition of fat, addition of steapsin, and enzylac. Further study under commercial conditions is being planned. F.W.B.

6. The New York State Cheese Improvement Program. J. C. MARQUARDT, N. Y. State Dept. of Agr. & Mkts., Geneva, N. Y. 18th Ann. Rpt. N. Y. State Assoc. Milk Sanit., pp. 9–16. 1944.

In 1942 and 1943 more than three-fourths of the Cheddar cheese made in New York State was manufactured from milk diverted from fluid markets. There has been some trouble due to slow acid development which has been largely overcome. About one-fourth of all the Cheddar cheese was made in five plants. About 70 per cent of the Italian cheese was made in two plants.

The program to improve cheese includes sediment testing, milk cooling, mastitis eradication, methylene blue and resazurin tests, proper can washing, improved lactic cultures, and better manufacturing procedures.

The Cheddar cheese is made chiefly from raw milk and "although cheese has never been a public health hazard, changing food habits may make it one." A.C.D.

CHEMISTRY

7. The Component Acids of Milk Fats of the Goat, Ewe, and Mare. T. P. HILDITCH, Dept. of Indus. Chem., Univ. of Liverpool, AND H. JASPERSON, Res. Dept., Messrs. J. Bibby and Sons, Ltd., London. The Biochem. Jour., *38:* 443–447. 1945.

Fats obtained from samples of goat, ewe and mare milks were studied by fractionation analyses of the methyl esters.

"The general similarity between goat- and ewe-milk fats has been confirmed, and differences have been indicated by the relatively higher content of decanoic and a relatively lower content of stearic acid in goat-milk fat than in ewe-milk fat.

Mare-milk fat, which has not been analyzed in detail hereto, has been shown to comprise the following acids (% by mol.); butyric 1.1, hexanoic 1.9, octanoic 4.4, decanoic 7.9, lauric 6.8, myristic 7.4, palmitic 15.4, stearic 2.4, as arachidic 0.2, decenoic 1.3, dodecenoic 1.2, tetradecenoic 1.9, hexadecenoic 7.2, oleic 16.3, octadecadienoic 6.6, linolenic 14.0, unsaturated C_{20-22} 4.0. The most arresting features are the low butyric and hexanoic acid contents and the presence of substantial proportions of linolenic acid amongst the C_{18} unsaturated acids." A.O.C.

8. Human-milk Fat. 2. Component Glycerides. T. P. HILDITCH AND M. L. MEARA, Dept. of Industrial Chemistry, Univ. of Liverpool.

The Biochem. Jour., *38:* 437–442. 1945. (See also previous work by same authors. Abstract 392. December, 1944.)

The method employed was to crystallize the human-milk fat systematically from acetone at various temperatures, five groups in all, and to study each group by the ester fractionation procedure.

"1. Human-milk fat glycerides consist of about 24% of di-unsaturated glycerides in which the mono-saturated group is myristic, lauric or decanoic acid, about 19% of palmitic di-unsaturated glycerides, about 20% of glycerides containing one radical each of palmitic acid, unsaturated acid, and one of the C_{10}, C_{12}, or C_{14} acids, about 14% of mono-unsaturated-palmitosterins, and minor proportions of various other mixed glycerides.

"2. The proportions of mono-palmito-glycerides and of glycerides containing one radical of either of the lower saturated acids have close resemblances to the proportions of the corresponding groups of glycerides in cow-milk fats, and thus suggest that the origin of the short-chain glycerides may be the same in both fats.

"3. It is probable that the di- and tri-unsaturated glycerides of human-milk fat contain one radical of linoleic or other unsaturated acid, the remainder being oleic, and that the mono-unsaturated glycerides are almost wholly mono-oleo-glycerides. It is also possible that the source of milk-fat short-chain glycerides may be linoleic-glycerides rather than oleo-glycerides as previously suggested." A.O.C.

9. **Estimation of Sucrose and Lactose in Binary Mixtures with Particular Application to Sweetened Condensed Milk.** H. H. Browne, Div. Dairy Res. Lab., Bur. Dairy Indus., U. S. Dept. of Agr., Wash., D. C. Jour. Indus. Engin. Chem., Analyt. Ed., *17*, No. 10: 623. Oct., 1945.

This method is based on the fact that sodium bi-sulfite decreases the optical rotation of aldose sugars and that the optical rotation of a mixture of two sugars, at least one of which is such a sugar, can be made a linear function of the concentration of each sugar. The method consists of two steps: the determination of the percentage of total sugars by means of the refractometer and the measurement of the optical rotation of a solution containing a known percentage of total sugars in the presence of sodium bisulfite. Data are presented for the optical rotation of sucrose-lactose mixtures and for the application of the method to a sample of sweetened condensed milk. B.H.W.

CONCENTRATED AND DRY MILK; BY-PRODUCTS

10. **Continuous Process Developed for Making Lactic Acid from Whey.** Anonymous. South. Dairy Prod. Jour., *38*, 3: 68. Sept., 1945.

Lactic acid, a chemical suitable for many industrial uses and one that

can be made by fermenting almost any kind of sugar, was first identified in sour milk about 160 years ago. But it was never made commercially from milk sugar until after the Bureau of Dairy Industry process was developed, although it had been made in this country from other sugars for more than 50 years.

The fermentation in whey may be carried out continuously by the use of a mixed culture of a lactobacillus and a mycoderm (a yeast-like organism), the acidity of the whey being kept within a certain range by the addition of slaked lime. Over 95 per cent of the milk sugar was thus converted to lactic acid.

A hundred pounds of whey contains five pounds of milk sugar. Estimating the value of sugar at 2½ cents a pound, whey would be worth 12½ cents per hundred pounds. Lactic acid has many uses itself and is also the material from which other chemicals can be made. F.W.B.

11. Consumer Acceptance of Dried Milk in Houston, Texas. ANONYMOUS. South. Dairy Prod. Jour., *38*, 3: 66. Sept., 1945.

Under wartime pressures the production of dried milk has been expanded. Consequently, when the wartime needs come to an end, there will be the problem of whether or not dried milk will be accepted by the general public. In many sections of the country, especially in the Southern deficit milk-producing areas, it is possible that consumption of milk could be increased by merchandising dried milk of a good quality.

At the request of the Division of Marketing and Transportation Research, the Division of Program Surveys of the U. S. Department of Agriculture conducted a survey to determine consumer's reaction to dried milk in an area which has experienced a milk shortage. Houston, Texas, represents such an area. For more than a year, dried whole and dried skim milk have been sold in Houston. Two hundred fifty-three buyers of dried milk and 479 non-buyers were interviewed.

Dried milk has been purchased in approximately one-sixth of the households in Houston. Many more people have bought dried whole milk than have bought dried skim milk. Most people who have not bought dried milk did not know that it is being sold. Dried milk has been bought because of a scarcity of fresh milk, simply as an experiment or because it is economical. Nearly one-half of the purchasers have bought only one package.

People think that the best use of dried milk is for cooking or baking. Approximately 90 per cent of the people who have used dried milk used it in reconstituted form. About one in five of the users say its preparation is difficult. One-half of the people who have bought dried milk say they expect to use it after the war. Dried whole milk will be in greater demand than dried skim milk. F.W.B.

FEEDS AND FEEDING

12. The Utilization of Urea in the Bovine Rumen. 4. The Isolation of the Synthesized Material and the Correlation Between Protein Synthesis and Microbial Activities. J. A. B. SMITH, Hannah Dairy Res. Inst., Kirkhill, Ayr, The County Technical Col., Guildford. The Biochem. Jour., *38:* 496–505. 1945.

"Rumen liquor has been incubated *in vitro* with and without added carbohydrates. The synthesis which results under favourable conditions has been estimated by isolating the synthesized material as an amorphous powder which consists mainly of bacteria.

"Synthesis of protein is accompanied by synthesis of a starch-like polysaccharide and by an increase in the iodophile population of the medium.

"The greater portion of the synthesis is attributed to the mass of micro-iodophile bacteria which abound in the rumen. Protozoa do not appear to contribute to the synthesis.

"Typical analytical figures for the sediment containing the synthesized material are 0.5% moisture, 36.3% protein, 46.6% polysaccharide, 9.5% lipoid matter and 6.2% ash. These values are very similar to the corresponding values for a typical feeding stuff such as linseed cake." A.O.C.

FOOD VALUE OF DAIRY PRODUCTS

13. Milk Abounds in Anti-Anemia Factors. ANONYMOUS. South. Dairy Prod. Jour., *38,* 3: 28. Sept., 1945.

Anemias originate either from the loss or destruction of red blood cells and/or hemoglobin or from a failure in their formation. The nutrients which apparently help to build and maintain red blood cells and hemoglobin are protein, iron, copper, riboflavin, pyridoxine, niacin, and pantothenic acid. Experiments on human beings lead to the conclusion that a diet adequate in all respects should be recommended for the prevention of nutritional anemias. All the nutrients known to be involved in the prevention and control of anemia occur in milk in appreciable quantities with the exception of iron and copper which are present in small amounts. F.W.B.

HERD MANAGEMENT

14. Saving Labor for the Dairy Farmer. JOHN A. HITCHCOCK, Vt. Agr. Expt. Sta. 18th Ann. Rpt. N. Y. State Assoc. Milk Sanit., pp. 47–52. 1944.

During a period of four months various alterations and adjustments were made on the dairy farm of Leonard Clark of Fletcher, Vt., to affect labor economies in the dairy barn. These changes may be grouped under (1)

rearrangements within the barn, (2) improved equipment, (3) improved work routines, especially timed milking, and (4) improved positioning of equipment and supplies.

"In terms of hours and minutes the reduction in time was from 5 hours, 44 minutes, to 3 hours, 39 minutes, a saving of 2 hours, 5 minutes; in terms of miles that in travel was from 3¼ to 1¼ miles, a saving of 2 miles. These savings represent 36 and 62 per cent, respectively, of the original time and travel. Two hours a day is equivalent to more than 60 12-hour days a year, a good full 2 months work; 2 miles a day is equivalent to 730 miles a year."

J.G.A.

ICE CREAM

15. The Use of Stabilizers in Ice Cream. H. A. BENDIXEN, Wash. Agr. Expt. Sta., Pullman, Wash. South. Dairy Prod. Jour., *38*, 1: 68. July, 1945.

Mixes and ice creams containing 0.5 per cent oatgum were compared with similar products containing 0.22 per cent sodium alginate. The oatgum was mixed with four times its weight of sugar and sprinkled in the mix at about 80° F. The sodium alginate was dispersed in cold water and added at 160° F. The mixes contained 11–12 per cent fat and 34–35 per cent total solids.

When no egg yolk powder was used the use of oatgum produced a slightly higher viscosity than the use of sodium alginate. The oatgum mixes increased 20–30 per cent in viscosity during aging for three days at 38–40° F. while the viscosity of the sodium alginate mixes increased very little.

When 0.4 per cent egg yolk powder was used in the mixes the oatgum mixes usually had only slightly higher viscosity. The whipping ability of the oatgum mixes was very similar to that of the sodium alginate mixes. There was no difficulty in any case, in obtaining 100 per cent overrun, with or without egg yolk powder. The oatgum mixes showed a higher melting resistance at 75–80° F. room temperature than the sodium alginate mixes. The slightly greater residue left by the oatgum mixes on a wire screen after melting was not significant.

From the standpoint of flavor, texture and general consumer acceptance, there was little practical difference between the ice creams containing oatgum and those stabilized with sodium alginate. F.W.B.

16. Shrinkage Defect in Ice Cream. Part II. DENZEL J. HANKINSON AND CHESTER D. DAHLE. South. Dairy Prod. Jour., *36*, 5: 34, 36. Nov., 1944.

Variations in fat content from 10 to 16 per cent caused little if any effect on shrinkage, when the sugar content of the non-fat portion was kept con-

stant. Ice cream from a mix containing 10.5 per cent serum solids showed slightly more shrinkage under vacuum treatment than that from a mix containing 8.0 per cent serum solids when the other mix constituents were constant. No shrinkage occurred in the latter samples without vacuum treatment. More shrinkage was evident in ice cream containing plain condensed skim milk than in that containing superheated condensed skim milk under all the test conditions used in these experiments.

Developed acidities of 0.015, 0.025 and 0.040 per cent had little if any effect upon shrinkage. Ice cream containing cane sugar or cane sugar with a substitution of 30 per cent of corn syrup, Sweetose, Cerelose, Frodex and honey on a dry basis in different lots showed no appreciable shrinkage without vacuum treatment. Vacuum-induced shrinkage was least in the ice cream containing corn syrup followed by those containing Sweetose, Cerelose and Frodex which showed about the same shrinkage. The ice cream containing honey showed the most shrinkage.

The use of 0.3 per cent gelatin and no stabilizer in separate mixes resulted in the least vacuum-induced shrinkage while 0.4 per cent Vesterine, 0.0225 per cent Articol, and 0.25 per cent Dariloid resulted in slightly more shrinkage. No appreciable change occurred without vacuum treatment.

A forewarning temperature of 175° F. in the skim milk before condensing resulted in slightly less vacuum-induced shrinkage than temperature of 125° F., 150° F., or 200° F. All samples not vacuum-treated showed no significant changes.

A mix containing butter showed less shrinkage than a similar mix containing 0.5 per cent dry egg yolk also. When egg yolk and egg whites were added to mixes containing cream there was less shrinkage than in mixes from which they were omitted. Shrinkage loss was greater in ice cream produced from vacuum-pan mixes than in cases in which the mixes were made by the conventional method.

It is impossible to conclude that either the vacuum treatment or an external pressure treatment is a satisfactory method for studying the effect. Either treatment may permanently destroy many of the individual air cells. Shrinkage occurs more readily at a higher overrun. F.W.B.

17. **Production Limited by Scarcity of Sugar.** C. D. Dahle, Dairy Dept., Pa. State College, State College, Pa. Ice Cream Field, *46*, No. 3: 13. 1945.

The sugar shortage forces ice cream manufacturers to get more sugar alternates or reduce the sweetness of their ice cream. It is stated that 12 per cent sugar mixes will be acceptable in place of higher sugar content mixes, but it is recommended that fairly high serum solids be used to offset the low sugar content. The author also confirms other reports showing that corn syrup and "Frodex" have greater sweetening power than was originally assigned them.

Reducing the amount of sherbet manufactured will enable the industry to make more ice cream and a greater total gallonage. Calculations are tabulated to show that if 900 pounds of sugar are used in the manufacture of ice cream, 1203 gallons can be produced; whereas if the same sugar were used to make sherbets, only 432 gallons would be produced. W.C.C.

18. A Sound Frozen Food Business Is Built by a Mid-West Ice Cream Manufacturer. MARJORIE SMITH. Ice Cream Field, *46*, No. 3: 42. 1945.

A brief account is given of the growth of the Squire Frozen Food Lockers and Squire Ice Cream Company of Shenandoah, Iowa. Squire believes that locker plants furnish good outlets for wholesale manufacture of ice cream and "locker traffic" increases the sale of ice cream and other dairy products for retail operation. W.C.C.

19. Use Ascorbic Acid to Blanch Apricots and Peaches. ANONYMOUS. Ice Cream Field, *46*, No. 3: 51. 1945.

Charles Collins, Frosteraft Packing Company, San Jose, California, is quoted as saying that a new process for apricots and peaches, which utilizes ascorbic acid (Vitamin C) in place of steam blanching, preserves the natural freshness and flavor of the fruit and prevents discoloration at the time of defrosting.

Fresh fruit was first treated on a commercial scale in 1941, but lack of availability of ascorbic acid during the war period has prevented its general use until now.

Various research agencies have cooperated in the project according to the report, and it is stated that over a million pounds of apricots were packed by this process this year. W.C.C.

20. New Orleans Claims First American Ice Cream. ANONYMOUS. Ice Cream Field, *46*, No. 3: 26. 1945.

A clipping from *Times-Picayune*, a New Orleans newspaper, declares that ice cream was first served in New Orleans in 1808—four years before President Madison took office. This discredits the belief, held by some, that Dolly Madison introduced ice cream to America by serving it at the White House during the administration of President James Madison. W.C.C.

21. Egg Solids Improve Ice Cream Quality. B. I. MASUROVSKY, Res. Editor, Ice Cream Trade Jour., *41*, 9: 56. Sept., 1945.

With the production of dried eggs greatly increased during the past three years, it has been suggested that the ice cream industry might use them in good quantities in the post-war period. Experimental work has shown

that 0.5 per cent egg yolk solids improves the whipping property of the ice cream mix.

Dried eggs should be kept in proper containers in a dry storage space and when a container is opened its entire contents should be used to prevent spoilage.

Dried eggs may be incorporated into the mix by mixing them with part of the sugar and adding them to the mix when it reaches 100° F. For French ice cream 1.5 per cent of dried yolks may be used.

The following information is taken from Circular No. 583 of the U. S. Dept. of Agriculture, entitled: "Eggs and Egg Products," and should serve as a guide in figuring the amount of egg yolk: "A case of 30 dozen eggs weighs about 42 to 43 pounds net and yields approximately 35 pounds of liquid whole egg. One hundred pounds of shell eggs produces commercially about 84 pounds of liquid whole egg. Twenty whole eggs, 36 whites, or 48 yolks make 1 quart of product. The liquid egg from 9 to 11 shell eggs will weigh about 1 pound, and 17 to 20 whites or 19 to 22 yolks weigh one pound. One pound of dried eggs can be made from 29 liquid eggs; 1 pound of dried yolk from 48 yolks, and 1 pound of dried albumen from 70 whites."

W.H.M.

22. Liquid Sugar's Rôle in Ice Cream Plants. B. I. MASUROVSKY, Res. Editor, Ice Cream Trade Jour., *41*, 6: 52. June, 1945.

The use of liquid sugar in ice cream has proven advantageous from a sanitary standpoint and has provided a convenient way of furnishing sugar solids for ice cream. In using liquid sugar, its water content must be taken into consideration. A 38° Baume liquid contains 3.28 pounds of water and 8 pounds of sugar solids per gallon. To make 100 gallons of ice cream mix (900 lb.) containing 14 per cent sugar solids would require 900 times 0.14 or 126 lb. of dry sugar and 126 divided by 8 or 15.75 gallons of liquid sugar. The amount of liquid sugar would contain 15.75×3.28 or 51.6 pounds of water which must be taken into consideration in calculating the remaining ingredients of the mix. Considerable time and labor can be saved by using liquid sugar.

The general picture of handling dry sugar is as follows: 1. Unloading of bags from delivery trucks. 2. Lifting of bags from elevators and carts into stock rooms or storage place. 3. Carting the bags to the processing room. 4. Cutting open the bags and dumping the sugar into the tanks. 5. Handling of empty bags.

In contrast, the general picture of utilizing liquid sugar in an ice cream plant is resolved into two steps: 1. Pumping the liquid sugar from the tank truck to storage tanks. 2. Metering the required amounts of liquid sugar by the turn of a valve, from storage tanks into the mixing receptacles or pasteurizing tanks. Furthermore, the liquid sugar system provides a more

sanitary handling of sugar solids by eliminating possible contamination through dust, dirt, bag lint and other foreign matter.

Already a large number of ice cream manufacturers have accepted the closed system of handling liquid sugar, because in a progressive food industry steps must be taken to improve the finished product by eliminating contamination. W.H.M.

23. **Dehydrated Sweet Potato Flour in Ice Cream.** A. J. GELPI AND P. G. KENNEDY, La. State Univ., Baton Rouge, La. South. Dairy Prod. Jour., *38*, 3: 38. Sept., 1945.

Recently dehydrating plants have been constructed which are manufacturing millions of pounds of wholesome and nutritious dehydrated sweet potatoes low in starch content and high in Vitamin A and carotene content. This product has been used satisfactorily in ice cream, sherbets, and ices at Louisiana State University.

The amount of sweet potato flour which should be added to a mix as a stabilizer depends upon the composition of the mix as well as the condition of processing. The range between 0.75% and 1% will usually be found satisfactory in most instances.

Ice cream mix stabilized with dehydrated sweet potato flour was found to possess the following properties: 1, Slightly more color than gelatin mixes; 2, A uniform viscosity during aging. The viscosity of the freshly made mix was practically the same as the aged mix; 3, A maximum whipping ability immediately after being viscolized and cooled to 40° F.; 4, No tendency toward wheying-off.

The ice cream made with mix stabilized with sweet potato flour was found to possess the following properties: 1, A color slightly darker than gelatin ice cream; 2, Body and texture comparable to gelatin ice cream; 3, Good water binding capacity; 4, No tendency toward shrinking; 5, Smooth, clean and satisfactory melt-down; 6, It was also observed that sweet potato stabilized ice cream withstood head shocking to a greater extent than ice cream containing other stabilizers.

In experimental trials it was found that sweet potato flour could replace as much as 3% of the serum solids in ice cream. The sweet potato flour not only replaces 3% of the serum solids but at the same time replaces the necessity of additional stabilizer, 1% of the sugar content and practically all the color. The finished product has good flavor, excellent body and texture, and excellent whipping qualities as 130% overrun was reached in five minutes after ammonia was shut off.

It should be understood that the use of sweet potato flour or any other product in ice cream as a substitute for part of the non-fat solids is to be recommended only during periods of emergency such as have existed in the immediate past. F.W.B.

24. Educating Fountain Clerks. G. P. GUNDLACH AND C. W. ESMOND. Ice Cream Trade Jour., *41*, 9: 70. Sept., 1945.

During the war many ice cream sales departments have maintained their sales department somewhere near full strength. Now that the war is over, sales managers will be faced with the problem of training new sales people. Providing manuals, making demonstrations and showing pictures will help, but the best way is for the sales managers of the wholesale manufacturers to personally teach and demonstrate and counsel and admonish and inspire and everlastingly "follow through" with the individual clerks serving in the stores of their dealers. W.H.M.

25. Fourteen Points for Post War Plant Operation. H. A. ACKERMAN, Dairy Mfg. and Res. Bur., G. P. Gundlach & Co., Cincinnati, O. Ice Cream Trade Jour., *41*, No. 8: 39. Aug., 1945.

Ice cream manufacturers should put good operating practices into effect now, if they expect to meet post war competition successfully. Some of the factors which are characteristic of sound plant operation are: 1, Good personnel relations; 2, Well-planned buildings and plant layouts; 3, Well-planned plant operations; 4, Large hardening rooms (at least large enough to hold 5 days maximum production); 5, Preventive maintenance; 6, Conveyors to handle material; 7, Good supervision; 8, Line production methods; 9, Improved cleaning and sterilizing operations; 10, Good house-keeping methods; 11, Quality control by means of a good laboratory; 12, Close attention to overrun control; 13, Proper plant accounting; 14, The use of good fruits and flavors. W.H.M.

26. Ice Cream with Reduced Sugar Content. HARRY PYENSON AND P. H. TRACY, Dept. of Dairy Husb., Univ. of Ill., Urbana, Ill. Ice Cream Trade Jour., *41*, 9: 30. Sept., 1945.

During the fourth quarter of 1945 ice cream manufacturers are limited to 50 per cent of the sugar used during the base period. With unlimited quantities of butter fat and milk solids now available, manufacturers are trying to stretch their supply of sugar as far as possible.

Experiments have been conducted at the University of Illinois to study the effect of reduced amounts of sugar on the body, texture and flavor of ice cream. The results of these experiments showed that a reduction in sugar content, (1) raises the freezing temperature of the mix, (2) raises the drawing temperature, (3) speeds up whipping of the mix, and (4) raises the dipping temperature.

The sugar content should not be lowered to less than 10 per cent in plain ice cream and an improvement in body texture of low sugar ice cream can be effected by raising the solids-not-fat up to 13 per cent. Cereal solids may

also be used for this purpose. In making chocolate ice cream with a reduced sugar content, it is advisable to lower the amount of chocolate flavor used.

W.H.M.

27. **Three-year Analysis of Wartime Sales.** VINCENT M. RABUFFO, Editor. Ice Cream Trade Jour., *41*, 9: 38. Sept., 1945.

A report released by the International Association of Ice Cream Manufacturers shows that 1944 sales of all products increased 9.09 per cent in 1944 over 1943. The sales in 1944 were divided as follows: Ice cream sales to civilians, 67.21%; ice cream sales to armed forces, 13.85%; ice milk and low fat products, 2.33%; milk sherbets, 10.58%; fruit ices, 6.03%. The sale of sherbets increased from 2.95 per cent of the total sales in 1942 to 11.98 per cent in 1944, and fruit ices from 2.32 per cent in 1942 to 6.83 per cent in 1944. Sales in Canada increased 3.51 per cent in 1944 over 1943.

W.H.M.

28. **Preparation of Irish Moss Extracts for Use as a Jelling and Stabilizing Agent in Foods.** C. O. FULTON AND MISS B. METCALFE, Nat. Res. Council Lab., Ottawa, Canada. Canad. Jour. Res., *23*, Sec. F, No. 4: 273. 1945.

Hot water extracts of bleached Irish moss were clarified by treatment with activated charcoal and filtration through diatomaceous earth after which the extract was concentrated by freezing and removing the ice. Further drying to a moisture content of 8 to 10 per cent was accomplished by means of a fan after which the product was ground in a Wiley mill.

The material was effective in stabilizing chocolate milk in the same concentration as a product now on the market. It was preferred to agar-agar in jellied canned chicken but was not a complete substitute for pectin in grape jelly.

O.R.I.

29. **Use of Dried Eggs in Ice Cream.** CARL FRISCHKNECHT, Senior Marketing Specialist, War Food Administration, Wash., D. C. South. Dairy Prod. Jour., *37*, 6: 34, 48. June, 1945.

Needs of the war period have resulted in 121 egg-drying plants in this country in 1944 compared to only 16 in 1941 and a production of 320,742,000 pounds of dried eggs in 1944 compared to 7, 487,000 pounds in 1940. Serious thought should be given now to practical uses of dried egg products during the post war period.

It is apparent from the information presented that dried egg yolk and dried whole eggs of high quality have a definite place in the manufacture of all kinds of ice cream. They are less expensive per unit and they can be stored and added to the mix with less waste and greater ease than fresh or

frozen eggs. It is quite generally agreed that the addition of dried eggs improves the whipping qualities of the mix, reduces the time required to obtain the overrun, adds color; increases the food value, smoothness and stiffness; and makes the ice cream more resistant to melting. Mixes containing one per cent and two per cent of egg solids each received good consumer acceptance in taste test panels conducted recently. Further research work and educational programs are needed. F.W.B.

MILK

30. Cost of Producing Milk in Illinois Portion of the St. Louis Milkshed. R. H. WILCOX AND C. S. RHODE. Ill. Agr. Expt. Sta. Bul. 515. 21 pages. Aug., 1945.

Cows averaged 7,762 pounds of milk yearly in the 198 herds included in this study. Feed expenses constituted 44.5 per cent and man labor 25.5 per cent of the net cost of producing milk. The remainder, 30 per cent of the cost, was made up by thirteen other items. The higher producing cows required less feed and labor per unit of milk produced than the lower producing cows. Hay and pasture produced the greatest feed variation. The facts concerning feed and labor costs are used as the basis for working out formulas and graphs. These figures compute milk costs for herds producing from 5,500 to 9,000 pounds per cow yearly. The only variable in the formulas are the local price of shelled corn and the cash wages of the hired help.

Some of the causes for variations in cost are given. The unit cost of production is reduced by (1) high production per cow, (2) large herds, (3) milking machines. The average yearly profit per cow in these herds studied in 1938 and 1939 was $11.19. The herds in which high seasonal variations in milk production were kept down were more profitable than those in which production was allowed to vary widely. Seasonality of production was influenced mainly by the time of year the cows freshened and the feed program followed. H.P.

31. Coliform Bacteria in Pasteurized Milk—the Utilization of Laboratory Control Methods. ROBERT S. BREED, N. Y. State Agr. Expt. Sta., Geneva, N. Y. 18th Ann. Rpt. N. Y. State Assoc. Milk Sanit., pp. 157–167. 1944.

Growth of coliform bacteria in raw milk makes the coliform test of little value in indicating initial mammal pollution. Furthermore, the coliform bacteria may not come from mammal contamination.

The situation is different for freshly pasteurized milk. McCrady has shown that freshly pasteurized milk in 1 ml. quantities can be free from coliform bacteria. The coliform test is widely used on pasteurized milk to

indicate recontamination after pasteurization. It is doubtful if tests on pasteurized milk 24 hours old has much value due to the possibility of growth at unknown temperatures.

Two agars and two fermentation tube technics are given in Standard Methods. The author favors formate ricinoleate broth but notes that agars are used as extensively as broths. While certain bacteria other than coliform gave positive broth tests, these organisms are not common in milk and most of them (except some spore-formers) are destroyed by pasteurization.

A.C.D.

32. Coliform Bacteria in Pasteurized Milk—as Affected by Using an Acid Detergent for Can Washing. HENRY W. LEHMKUHL, Milk Plant Specialties Corp., Rochester, N. Y. 18th Ann. Rpt. N. Y. State Assoc. Milk Sanit., pp. 149–156. 1944.

Milk cans have generally been considered to be a source of alkaline-reacting, proteolytic types of bacteria rather than coliform.

Gluconic acid is common in acid washing solutions, the proprietary liquid contains the equivalent of about 25% gluconic acid and 2½% is recommended. The actual concentration of acid in the spray is about 0.6%. The undiluted liquid has a pH of 2.1; a 1% solution has a pH of 2.9 in distilled water and 3.1 in Rochester tap water. It was found that gluconic acid could not be used by coliform bacteria as a source of energy. A 2½% solution destroyed them in 5 seconds.

One milk plant was using two washers for milk cans, one with alkali and the other with acid washing solutions. The alkaline solution was maintained at 0.05% alkalinity and the acid solution was also alkaline, pH 8.3. Both washers did good work and cans were free from coliform bacteria.

Another plant using acid washing solution for shipping cans failed to produce physically clean cans. The cans were not prewashed but were rinsed, acid-sprayed, acid-washed at 160° F., hot-water sterilized, and hot-air dried. Counts were 150,000,000 to 50,000,000,000 per five-gallon can and five out of six cans were coliform-positive.

A.C.D.

33. Coliform Bacteria in Pasteurized Milk—Seasonal Fluctuations. C. W. WEBER, N. Y. State Dept. of Health, Albany, N. Y. 18th Ann. Rpt. N. Y. State Assoc. Milk Sanit., pp. 139–148. 1944.

Over 10,000 coliform tests were made in three health departments during three years. Positive tests showed gas in one or more of three fermentation tubes each inoculated with 1 ml. of pasteurized milk.

The results on pasteurized milk, cream, chocolate milk, cultured milk, and frozen desserts all show the lowest percentage of positive milks in cold weather and the greatest number in midsummer. The averages for percentages of samples coliform-positive showed a direct correlation to the mean

average temperature of New York State. There was no correlation between the percentages of the samples with standard plate counts over 30,000 and the mean average temperature. "The increase in positive coliform tests in the warm months is due to growth of the organisms in the milk and to a greater degree of contamination of the milk, the latter probably being the dominant factor." A.C.D.

34. Coliform Bacteria in Pasteurized Milk—Unsuspected Sources. J. F. JANSEN, Sheffield Farms Co., Oneonta, N. Y. 18th Ann. Rpt. N. Y. State Assoc. Milk Sanit., pp. 135–138. 1944.

Inspections were made of two bottling plants having trouble with coliform bacteria. The use of new and inefficient help was the principal problem. Instances of various disregards for sanitary practices were found. One boy drank from the milk bottles. Another lad rinsed sterilized cans with cold water from a hose to cool them before filling with pasteurized cream. Some valves were neglected. On a double holiday 16 out of 35 employees did not show up for work for three days. Some equipment was not clean. It was decided under such circumstances that until efficient help could be secured again chlorine sterilization would be eliminated. Sterilization by passing steam through the equipment for one-half to one hour greatly reduced coliform-positive samples of milk. Steam must not be used on a cabinet cooler refrigerated by brine. A.C.D.

35. Coliform Bacteria in Pasteurized Milk—Public Health Significance. J. M. SHERMAN, Cornell Univ., Ithaca, N. Y. 18th Ann. Rpt. N. Y. State Assoc. Milk Sanit., pp. 125–134. 1944.

The presence of coliform bacteria in milk represents direct or indirect contamination with undesirable (though not necessarily dangerous) materials. They cause undesirable fermentations.

Coliform bacteria were once thought to be exclusively of fecal origin. Rogers and Clark classified them into two groups on the basis of ratio on carbon dioxide to hydrogen in the gas evolved. The one group produced equal amounts of gas and were in the coli group; the other group produced 1.5 to 3 times as much carbon dioxide as hydrogen and were in the aerogenes group. Then Rogers, Clark, and Evans found the aerogenes group were found chiefly on grains and vegetation. Clark and Lubs developed the simple methyl red test to differentiate the group. Levine differentiated the two groups by the Voges-Proskauer test for acetylmethylcarbinol. Finally, Ayers and Clemmer showed coliform bacteria grew in partially cooled milk so that in such milk there is no correlation between numbers and initial contamination.

The presence of coliform bacteria in pasteurized milk indicates after-pasteurization contamination. A.C.D.

36. Structural versus Operational Inspections. M. ALLEN POND, U. S. Public Health Service, Washington, D. C. 18th Ann. Rpt. N. Y. State Assoc. Milk Sanit., pp. 109–124. 1944.

In 1940, a study was made of the effectiveness of inspection service for an eastern city of 75,000 population. There were 1040 farms in a radius of 70 miles supplying 42 pasteurization plants. Milk consumption was one pint per capita per day.

Ten important structural and equipment factors considered important in sanitary milk production were found to be unrelated to the number of farm inspections. However, there was a positive relationship between plant defects and number of inspections. There was no relationship between structural improvements on farms or in plants and the numbers of inspections. Most inspections were made on their farms and plants producing milk of poorest quality. Milk quality was not related to structural quality either on farms or in plants. More farms per day were inspected when the farms were located far from the city.

It was pointed out that inspections should be made on farms and in plants on the basis of laboratory reports and during actual operation. About 20% of the farms were inspected without seeing anyone. A.C.D.

37. Present and Future Production Problems in the New York Milkshed. C. J. BLANFORD, New York Metropolitan Milk Market Area, New York, N. Y. 18th Ann. Rpt. N. Y. State Assoc. Milk Sanit., pp. 87–100. 1944.

In studying the significant alterations in the fluid milk industry in the New York Metropolitan milkshed during the war, it is best to consider the changes as (1) changes in consumption and (2) changes in production.

Fluid sales in the New York area in 1944 are 19% higher than in 1940. The requirements are 326,000,000 pounds a month compared with 275,000,000 pounds a month in 1940. Sales of fluid cream have been regulated by quotas and the fat content limited to 19%. To some extent increased milk sales have been offset by decreased cream sales.

There has been a diversion of milk from New York to other large eastern cities so increased consumption of some other eastern cities exceeded that of New York. In 1941, the New York milk pool sold 313,000,000 pounds into other markets and in 1943 this amount had increased to 545,000,000 pounds. Since 1940 the number of milk plants supplying New York decreased from 496 to 450. The producers delivering milk to New York City plants decreased from 60,300 to 51,500 during the same time. It is believed that of these 8,800 fewer dairy farms, slightly over half sold to the 46 plants that left the market and the balance quit producing milk. The production of farms that remained in the pool increased 12% while the farms decreased 15%. The tendency has been to produce more milk during the summer season. A.C.D.

38. Uniform Design of Milk Houses. J. D. BOHN, Sheffield Farms Co., 524 West 57th St., New York, N. Y. 18th Ann. Rpt. N. Y. State Assoc. Milk Sanit., pp. 73–85. 1944.

Two years ago this association appointed a special committee to develop plans for uniform designs of milk houses that would be acceptable in the New York area. This committee enlisted the cooperation of H. W. Riley, Cornell University, and held several meetings with various groups represented. As a result plans were recommended and were presented with drawings and specifications.

Editor's note: Since this address a brief circular has been published entitled "Approved Milk House Construction" which is based upon the work of this committee. It is stated that "Milk houses constructed in accordance with these plans will meet the requirements of the following agencies": State Health Departments of New York, New Jersey, Pennsylvania, Vermont, and Connecticut; Municipal Health Departments of New York City, N. Y., Newark, N. J., Jersey City, N. J., Plainfield, N. J., Westchester County, N. Y.; Rutgers University, Pennsylvania State College, and Cornell University. A.C.D.

39. Local or Centralized Milk Inspection. G. W. MOLYNEUX, Westchester County Dept. of Health, White Plains, N. Y. 18th Ann. Rpt. N. Y. State Assoc. Milk Sanit., pp. 33–46. 1944.

The present Sanitary Code of New York State, exclusive of New York City, places responsibility for the sanitary control of milk supplies with the local health officers. The development and problems of this system of inspection were discussed. An attempt was made last year to place all dairy farm milk inspection under the control of the New York State Department of Health.

The bill, which was defeated, would have given central state inspection of all dairy farms. In cities with populations over 50,000 the inspection and control of milk within the respective borders of each city would be by the City Board of Health. City Boards of Health would control the inspection of pasteurization plants, distribution, permits, etc., and would even be able to reject raw milk not considered of proper quality. In cities less than 50,000 population, the entire inspection even within the city would be under state supervision. Such a central inspection would tend to give one uniform inspection per farm throughout the entire state and also for out-of-state shippers. The state would take over present city milk inspectors to do the work.

The discussion brought out that the original bill contained some economic features also and that some cities feared that less rigid standards would be enforced on the dairy farms. A.C.D.

40. Yami Yogurt—A Real Milk Food. ANONYMOUS. South. Dairy Prod. Jour., *37*, 5: 48. May, 1945.

Yogurt, a lactic cultured dairy product, has been a staple food in the middle East for many years and has been accepted with fervent zeal in Europe. The re-introduction of yogurt in the United States under the name of yami yogurt by the Yami Yogurt Products Company of Beverly Hills, California, has met with outstanding success.

The success in merchandising the product is attributed to its being offered as a staple food at a reasonable price rather than as a medicine, a forceful advertising campaign, and the use of a scientifically controlled culture. The Yami Yogurt Company and the Rosell Bacteriological Dairy Institute in Canada have developed literature, leaflets and posters for the promotion of sales. F.W.B.

41. New Method Keeps Processed Cream Fresh for Year or Longer. ANONYMOUS. South. Dairy Prod. Jour., *38*, 1: 48. July, 1945.

A new method of processing and sterilizing cream to keep cream pure, fresh and tasty for a year at room temperature is announced by Westinghouse Electric and Manufacturing Company, after six years of research by the California Milk Products Company, Gustine, California.

The processing includes the addition of 0.25 per cent vegetable "stabilizer," "flash sterilization" in four minutes at 260–280° F., bottling and hermetically sealing in a room freed electrically from dirt and bacteria by the use of the Precipitron air cleaner and ultra-violet rays produced by Sterilamps. When vital military requirements permit, other producers will be licensed to supply civilians, according to Mahlon K. Jordan, Vice-President of the Company. F.W.B.

42. Freezing Milk in Brick Form. GLORIA A. NERENBERG. Ice Cream Trade Jour., *41*, 6: 26. June, 1945.

A process has been developed at the Pennsylvania Agricultural Experiment Station by F. J. Doan and L. G. Leeder for the manufacture of frozen concentrated milk. Briefly, the process consists of pasteurizing good quality milk at 180° F. for 15 minutes, followed by condensing to one-third its original volume. The condensed product is homogenized, using 3000 to 3500 pounds pressure and then frozen in a continuous or batch ice cream freezer. After packaging the partially frozen milk, it is then placed in a freezing room at 10° F.

Frozen concentrated milk may be stored for several weeks at temperatures of −10° F. and below. When reconstituted by adding two parts of hot water, the product resembles fresh fluid homogenized milk. Professor Doan predicts that this new product may be used in many places where fresh milk is not available. W.H.M.

MISCELLANEOUS

43. Wrapping and Packaging Materials for Frozen Food Lockers. P. O. SHUTTLEWORTH, Zellerbach Paper Co., San Francisco, Calif. Refrig. Engin., *50,* 4: 311. Oct., 1945.

It is pointed out that moisture-vapor-proof type wrapper should be used for all products that may be frozen by locker plants, but cost must be watched in order that it may not become prohibitive—a balance between good protection and cost must be struck. It is suggested that a locker operator should exercise complete supervision over all patron-wrapped packages received even to the point of repackaging. Patron education in proper wrapping of foods for freezing is indicated as a means to insure customer satisfaction with his own home-prepared products. The locker operator should encourage diversification of items in a customer's locker. It is stated that the rectangular carton has been the style of frozen food container in recent years because of its space-conserving quality. Cellophane available in several special types seems to be the most satisfactory vapor barrier wrapper for general use for protecting frozen foods because of its impervious nature and the ease with which it may be heat-sealed. The prediction is made that home freezing units will become an asset to the locker plant rather than a competing item. L.M.D.

44. Insulation and Its Uses. Part I. P. EDWIN THOMAS, Senior Mechanical Engineer, Wash., D. C. Refrig. Engin., *50,* 4: 319. Oct., 1945.

Cold storage insulating materials may be divided into two kinds: (a) thermal insulation, and (b) sound insulation; also into four classes; (1) animal, (2) mineral, (3) chemical, and (4) vegetable; and then both kinds and classes may be divided into (a) housing, (b) industrial, (c) air conditioning, (d) food processing, and (e) food preservation. The paper is devoted chiefly to the thermal insulation aspect of the kinds of materials now produced and their adaptability to the several classes of application, the author pointing out the advantages of the various materials, their limitations and the service which they best may perform. L.M.D.

45. A Simple Method of Sealing Gas- or Vacuum-Packed Tins. W. A. BRYCE AND H. TESSIER, Nat. Res. Council Lab., Ottawa, Canada. Canad. Jour. Res., *23,* Sec. F, No. 5: 304. 1945.

A method of soldering tins within a desiccator or other chamber is illustrated and described. A $\frac{1}{16}$-inch hole in the center of the can cover is sealed with a pellet of solder, the heat for which is furnished from an electric heating coil of No. 18 chromel wire. The coils are clamped into position before placing the cans in the desiccator. When ready to seal the heating circuit is closed. The pellet of solder, previously hung in the upper part of the

coil, is melted and drops on the area about the hole, producing an effective seal. O.R.I.

46. Reduction of Spatial Temperature Variations in Air-Cooled Cold Storage Rooms. T. A. STEEVES AND W. H. COOK, Nat. Res. Council, Ottawa, Canada. Canad. Jour. Res., *23*, Sec. F, No. 4: 253. 1945.

Temperatures prevailing at different points in an experimental cold storage room with false floor were found to be subject to wider variations when boxes were present in the storage. By forcing the air to pass through the stack such variations were reduced to approximately the same values as those prevailing in an empty room. Dunnage spacing also reduced variations but no significant differences were found when spacings were varied from $\frac{5}{16}$ inches to 2 inches. O.R.I.

47. ABC's of Plant Refrigeration. LEON BUEHLER, JR., Creamery Package Mfg. Co., Chicago, Ill. 18th Ann. Rpt. N. Y. State Assoc. Milk Sanit., pp. 17–30. 1944.

The elementary physical facts that are basic to understand mechanical refrigeration systems are presented together with certain applications to dairy plants. A.C.D.

48. Truck Refrigeration. H. WILEY KROTZER, Engineer, Pioneer Ice Cream Div., The Borden Co., New York, N. Y. Refrig. Engin., *50*, 4: 324. Oct., 1945.

The writer presents a brief resume of refrigerated truck transportation development stating that pay loads have been doubled while the transportation costs, cost of chassis and body, and the number of vehicles required have been halved compared to the situation of 15 to 20 years ago. Out of his years of experience in building refrigerated truck bodies, Mr. Krotzer recommends the making of the following analysis before buying such vehicles: 1.) What product do you wish to transport? a. Is the product precooled. b. Allowable temperature limits. c. Time required for breakdown and repair factor. *d. Heat loss through vehicle walls. *e. Heat loss through door openings. *f. Total heat loss plus factor of safety. 2.) Amount of load and size of body. a. Construction. b. Insulation. c. Package shape and system of loading. 3.) Refrigeration analysis. a. Total Btu. required plus factor of safety. b. Portable or plant supply. c. Factor of safety in system chosen. d. Proposed time in years of operation. e. Investment and yearly depreciation both of refrigeration system and truck body. f. Care

* A more appropriate terminology would be heat gain when refrigeration is under consideration.

and upkeep. (Double your original estimates, since new installations get old faster than you realize.) g. Actual cost per day. (Be realistic about this—don't deadhead this operation just to get good costs.) h. Total costs per day, per year, or total cost per ton, on unit hauled. i. How does your driver like the vehicle and will he be better off in terms of salary or easier work by this system? 4.) If possible, consult an experienced transportation specialist and have him check your figures and make suggestions.

Emphasis is placed upon the role of body design to take care of factors of inherent moisture conditions, rusting of metals, rotting of wooden members, and nullification of insulation through moisture, rotting, fungus growth, settling, cracks, and frost deposits. L.M.D.

49. Vermin Control in Dairy Plants. PAUL W. REED, Captain SnC., before the Annual Meeting of the American Butter Inst., Chicago, Ill. Nov. 30, 1944. South. Dairy Prod. Jour., *37*, 3: 74, 80. March, 1945.

This paper is limited to the cockroach and the rodent. Both are the products of filth. Therefore, the best control is good housekeeping which denies the pest food and harborage.

The cockroach is nocturnal and hides during daylight hours near sinks, behind wall cabinets, under cracks in walls and floors and in dark food storage spaces. A permanent method of control is to seal these openings.

Sodium fluoride is the most effective poison against roaches. To be completely effective all possible hiding places must be sprayed or dusted weekly until all roaches disappear. Since sodium fluoride is a poison, it should be used intelligently. The Army uses the powder which has been colored green.

Powdered borax is less effective. A 1.5 per cent solution of boric acid in water distributed so as to be available for drinking is fairly satisfactory. Trapping is not successful as a rule. Baits containing phosphorus or arsenic may be used with success. Pyrethrum sprays are effective if they contact the roach.

Fumigation with hydrocyanic acid gas or methyl bromide is very effective against roaches and rodents, but the building must be taken out of use for 48 to 72 hours. Fumigation is much more expensive and should be done only by experienced personnel. DDT is no more effective than sodium fluoride for roaches.

Rats are very destructive and are also disease carriers. Control measures used against rodents are classified into two general classifications: the preventive procedures which include good housekeeping and rat proofing of buildings, and the destructive procedures which include baiting, trapping and fumigation.

Rat proofing is an engineering problem. The most successful poisons are

barium carbonate and red squill which are used by mixing thoroughly one part poison with sixteen parts of hamburger, oatmeal, cheese, fresh grain or other bait. The baits are most attractive to the rat when about a teaspoonful is wrapped in paper. Prebating is considered desirable.

The campaign must be quick and decisive to avoid suspicion and refusal of baits by the rats. Baits should be removed the following morning and baiting repeated after a two-week rest period with different bait.

The snap trap is preferred in trapping. However, the cage trap may trap large numbers. The bait on the trap must be large, attractive and securely attached to the trigger. Fifty or a hundred traps all set along the normal runways of the rodents, and if the baits do not attract the rats, the traps should be camouflaged. F.W.B.

50. Warning Agents in Odorless Refrigerants. R. J. THOMPSON, Kinetic Chemicals, Inc., Wilmington, Del. Refrig. Engin., *50:* 4, 313. Oct., 1945.

Odorants and irritants each have undesirable qualities which render them unsatisfactory as warning agents for detecting odorless refrigerant leaks. The necessary requirements for a warning agent whether odorant or irritant are given as: (1) Should be distinctive, powerful, non-flammable, and non-toxic; (2) Must not be corrosive to copper, brass, tin, lead, zinc, cast iron, steel, aluminum, or any other metal under the conditions of machine operation; (3) Must be stable in the presence of the refrigerant mineral oil, and moisture at temperatures of operation of the machine; (4) Must be soluble in the liquid and vapor phases of refrigerant, in mineral oil, and in mixtures of refrigerant and oil; (5) It should have such physical properties—namely, boiling point, melting point, vapor pressure, and solubility—that its presence at any moment in all parts of the refrigerating system will be assured; (6) It should require a relatively small concentration in refrigerant; (7) It should be low-priced and easy to manufacture. Mr. Thompson, however, does not advise the use of odorants or irritants in connection with Freon-charged apparatus. The high molecular weights of the Freons, particularly Freon 11 and Freon 12, cause them to have much lower leak rates than other refrigerants. The use of the halide lamp is recommended for Freon leakage detection with the warning that the pump-up type, or one with a brass burner does not give sufficiently rapid color change of the flame. Leaks of as low as one ounce of liquid per month, 0.06 per cent Freon vapor in air, are readily detected by this method. L.M.D.

51. Job Safety Training Manual. KENNETH L. FAIST AND STANTON M. NEWKIRK, Nat'l Foremen's Inst., Inc., Deep River, Conn. 1945.

Complete details are given for instituting instruction in job safety of foremen in connection with the establishment of a safety program. Largely

based upon the techniques of Job Instruction, Job Relations and Job Methods Training which have been developed during war period by the Training Within Industry (TWI) branch of the War Manpower Commission. The way to safety is based on four steps: (1) Analyze the Job; (2) Spot the Danger; (3) Act to Correct; (4) Check Back. These four steps of Job Safety Training should be used before giving a new man instruction, before giving an experienced man instruction, and when looking for danger spots to eliminate. Anyone can "spot the danger" AFTER the accident but if the educational aspect of the Job Safety program is carried out, accident incidents will be greatly reduced to the category of "unavoidable" accidents and man-hour work less minimized. L.M.D.

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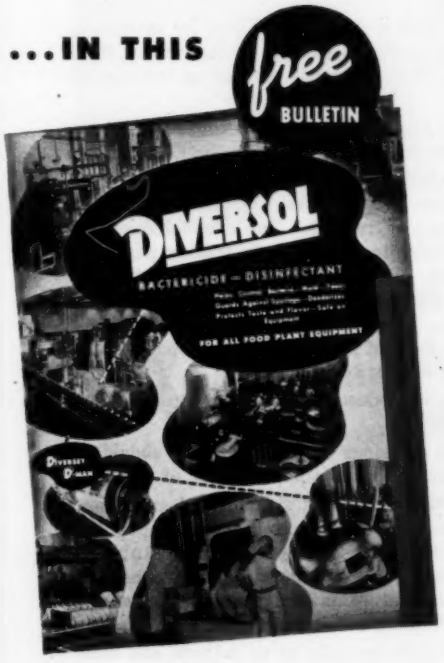

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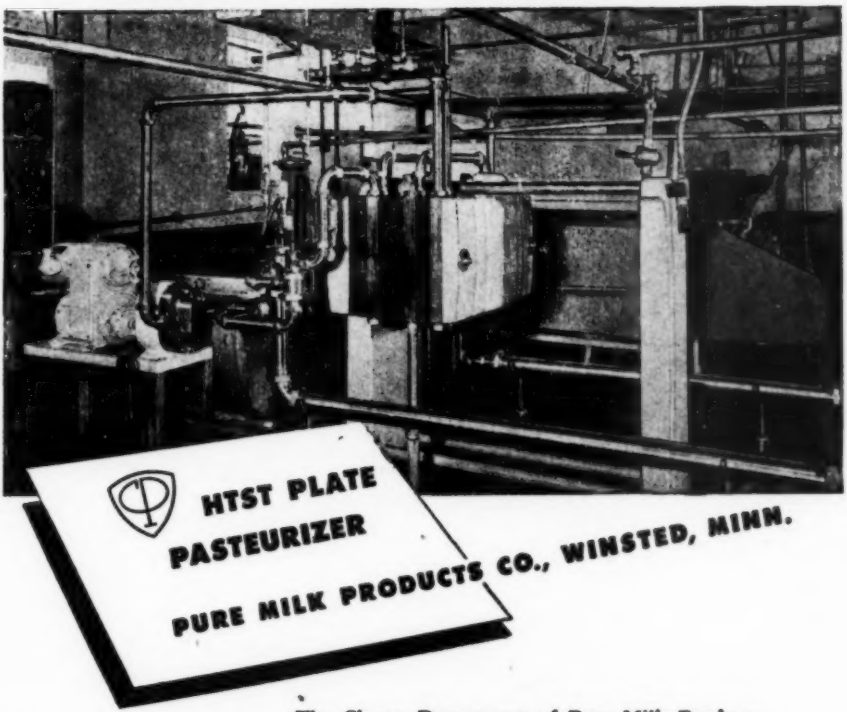

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